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Quality Extension of Star Apple (*Chrysophyllum cainito*) Fruit during storage by Melatonin Treatment

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Star apple (*Chrysophyllum cainito*) is non climacteric fruit having great nutritional values, excellent antioxidant capacity and diversified health advantages. This fruit has a short stability due to its high perishability. Melatonin have been successfully utilized as an alternative strategy to extend shelf life and commercial quality in many fresh fruits. This research evaluated the effectiveness of melatonin treatments (0.15-0.35 mmol/L) on weight loss (%), firmness (N), total soluble solid ($^{\circ}$ Brix), vitamin C (mg/100g), total phenolics (mg GAE/100g), and total flavonoids (mg QE/100 g) of star apple fruit during 30 days of preservation. Results showed that 0.3% melatonin application at improved retention of physicochemical indicators like moisture, texture firmness, total soluble solid, vitamin C as well as antioxidant substances like phenolics and flavonoids during storage of star apple fruit. Synergistic effects of melatonin and conventional preservation methods should be studied further for practical application of melatonin in post-harvest preservation of fruits and vegetables.

Keywords: Star apple, melatonin, weight loss, firmness, total soluble solid, vitamin C, total phenolic, total flavonoid

INTRODUCTION

The star apple fruit (*Chrysophyllum cainito*) has a smooth and waxy skin (Nguyen et al. 2019). It's a delicious fresh dessert fruit by creamy white pulp with several small seeds (Nguyen et al. 2018). Its sweet pulp contains excellent source of nutrients and phytochemicals such as vitamins and minerals (Oluwole et al. 2017). The aerial parts of *C. cainito* have multiple chemotherapeutic advantages such as antioxidants, antidiabetic, anti-inflammatory, anticancer, and antihypertensive properties on human health (Luo et al. 2002; Fernandez-Panchon et al. 2008; Meira et al. 2014; Li et al. 2015; Mao et al. 2015; Oranusi et al. 2015; Hegde et al. 2016; Doan et al. 2018; Hau and Thao, 2020). It's sensitive to weight loss leading to shrinkage and fruit softening in post-harvest, resulting in the decrease of its commercial value. The most popular postharvest quality degradations of star

apple fruit are fungal infection, physiological disorder, and physical injury (Nguyen and Nguyen, 2018). The harvest duration of star apple fruit is normally begun from December to March, and their quality become worse in a period of 5 days after harvesting at ambient temperature with the deterioration starting to change of color and followed by shrinking of the fruit (Amusa et al. 2003). Several reports mentioned to the storage of this valuable fruit. Nguyen and Nguyen (2018) applied agar/ glycerol as biodegradable coating on storage of star apple. Nguyen et al. (2018) examined chitosan as edible coating to preserve this fruit. The fresh star apples should be treated with electron beams at doses of 0.4 and 0.6 kGy (Nguyen et al. 2020).

Melatonin or N-acetyl-5-methoxytryptamine, is a hormone available in animals, plants, and microbes (Manchester et al. 2000; Burkhardt et al. 2001; Paredes et al. 2009; Posmyk and Janas,

2009). It's an indole derivative of tryptophan having high radical scavenging activity (Kolář and Macháčková, 2010). Melatonin is synthesized from tryptophan through the catalysis of tryptophan decarboxylase, tryptamine-5 hydroxylase, 5-hydroxytryptamine-N-acetyltransferase, and N-acetyl-5 hydroxytryptamine-methyl transferase in plants, which are then catabolized to 2-hydroxymelatonin by the action of melatonin 2-hydroxylase (Rui et al. 2016). It's involved in various biological processes in plants, including circadian rhythm and photo-response regulation (Hu et al. 2016), leaf senescence (Dhindsa et al. 1981), seed germination, and root growth (Zhang et al. 2012). It was demonstrated to ensure fruit tissues free from reactive oxygen and nitrogen species by two mechanisms: (1) direct free radical scavenging by giving electronic; (2) activation of antioxidant enzymes, and other antioxidants (Reiter and Tan, 2002; Arnao and Hernandez, 2015). Moreover, it has ability to control fruit maturity and quality like tomato; limit the fruit ripening in post-harvest and to modify the active oxygen metabolism in peach and strawberries (Qianqian et al. 2015; Liu et al. 2016; Gao et al. 2016; Aghdam and Fard, 2017). Melatonin has been reported in post-harvest preservation of some fruits and vegetables, including peach (Gao et al. 2016; Cao et al. 2018), cassava (Ma et al. 2016), banana (Hu et al. 2017), and cucumber (Li et al. 2016; Xin et al. 2017), apple (Cao et al. 2017), strawberry (Aghdam and Fard, 2017), lychee (Zhang et al. 2018), pear (Zhai et al. 2018), brocolli (Zhu et al. 2018), tomato (Sun et al. 2016), potato (Zhang et al. 2017). Objective of our study evaluated the effectiveness of melatonin treatments on physicochemical properties and phenolic compounds of star apple fruit during 30 days of preservation.

MATERIALS AND METHODS

Material

Star apple fruits were harvested from My Xuyen district, SocTrang province, Vietnam. After collecting, they must be quickly transferred to laboratory for experiments. They were subjected to air blowing to remove foreign matter. Chemical reagents were all analytical grade.

Researching method

Selected fruits were soaked in 25 ppm peracetic acid solution for 2 minutes for sterilizing, and washed three times with portable water. The

treatments were arranged in 6 different groups: control, 0.15%, 0.20%, 0.25%, 0.30%, 0.35% melatonin for 15 minutes. After dripping excess water, the fruits were stored in 6 perforated bags at $22\pm 2^{\circ}\text{C}$, 9 fruits in one bag. 3 samples were randomly taken for every 5 days during storage at 0, 5, 10, 15, 20, 25 and 30 days to evaluate weight loss (%), firmness (N), total soluble solid ($^{\circ}\text{Brix}$), vitamin C (mg/100g), total phenolics (mg GAE/100g), total flavonoids (mg QE/100g).

Physicochemical and antioxidant determination

Weight losses (%) was estimated by comparing weight of samples before and after the storage period. Firmness (N) was evaluated by penetrometer as the maximum penetration force (N) reached during tissue breakage. Total soluble solid ($^{\circ}\text{Brix}$) was determined by hand-held refractometer. Vitamin C (mg/100g) was analyzed by using 2, 5-6 dichlorophenol indophenols' method described by A.O.A.C (1990). Total phenolic (mg GAE/100g) content was determined using spectrophotometric method (Singleton et al. 1999). 5 ml of methanol was mixed with 5 g fruit pulp, 25ml of 10% FolinCiocalteu's reagent dissolved in water and 25 ml of 7.5% NaHCO_3 . Blank was prepared, containing 5ml methanol, 25ml 10% Folin-Ciocalteu's reagent dissolved in water and 25ml of 7.5% of NaHCO_3 . Samples were then incubated at 50°C for 15 min. The absorbance was recorded using spectrophotometer at $\lambda_{\text{max}} = 765\text{nm}$. The same procedure was conducted for the standard solution of gallic acid and the calibration line was established. Based on the absorbance, the total phenolic content was calculated from the calibration curve; the total phenolic content was expressed as a gallic acid equivalence (mg of GAE/100g of sample). Total of flavonoids (mg QE/100g) was examined using spectrophotometric technique (Quettier et al. 2000). 25 gram of pulp was extracted with 5 ml of methanol with the presence of 5 ml of 2% AlCl_3 solution. The samples were incubated for an hour at room temperature. This mixture was incubated for 30 minutes at ambient temperature. The absorbance was verified using spectrophotometer at $\lambda_{\text{max}} = 415\text{nm}$. The same procedure was repeated for the standard solution of quercetin and the calibration graph was established. Based on the measured absorbance, the content of flavonoids was calculated (mg/mL) on the calibration curve and the total of flavonoids was

expressed as a term of quercetin equivalent (mg of QE/100g of sample).

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

Respiration rate was the main cause resulting to moisture loss of fruit (Bhande et al. 2008). The firmness of fruits became soft from crisp. Their taste degraded, and their resistant capacity against physical and microbial pathogen also came down (Velickova et al. 2013). Weight loss (%) of treated and non-treated samples were carefully monitored within 30 days of storage at 22±2°C in perforated bags. The weight loss (%) was clearly presented in table 1. Our results revealed that star apple fruits treated by melatonin 0.30 mmol/L showed the lowest weight loss (%). There was not significant difference between the samples treated by 0.30 mmol/L and 0.35 mmol/L within the first 20 days of storage. Afterward, there was significant difference between the samples treated by 0.30 mmol/L and 0.35 mmol/L. The results indicated that melatonin treatment delayed the weight loss of star apple fruit during storage. In the post-harvesting stage, fruit weight loss rate increased accompanied by hardness decrease (Matsumoto et al. 1983). Melatonin may affect water loss in fruit by altering the expression of some aquaporin genes (Qianqian et al. 2015).

Texture firmness of fruit not only affects consumer preference, but also has a significant influence on stability and distribution. The firmness of fruits is closely correlated with acceptability of fruits. Softening is believed as a result of cell wall disassembly, decreased cell adhesion (Vicente et al. 2007; Lunn et al. 2013). The changes in cell wall structure are accompanied by a solubilization of pectins and depolymerization of hemicellulosic polysaccharides (Qianqian et al. 2015). Apart from the structural matrices of the cell wall, another important contributor to texture and fruit firmness is cellular turgor (Alleva et al. 2010). Cellular turgor is governed by the water status within fruit and the relative water distribution within the cell and in the cell wall (Seymour et al. 2013). The senescence of fruits and vegetables is accompanied by the loss of cell membrane integrity and function, which is manifested by an

increase in membrane leakage (Dumas et al. 2003). This structural/functional membrane dysfunction is caused by the excessive production of reactive oxygen species (ROS), including O₂⁻, H₂O₂, hydroxyl radical (OH⁻), and singlet oxygen (¹O₂), which are potent compounds destroying biological macromolecules and affecting the metabolism of post-harvest fruits and vegetables. During storage, the ROS in fruits increases continuously and induces lipid peroxidation (Li et al. 2016). Lipid peroxidation can catalyze the oxygenation of unsaturated fatty acids through ROS and lipid oxidases (such as LOX) to create volatile substances such as hydrogen peroxide derivatives (Shewfelt and del Rosario, 2000). Subsequently, these substances are decomposed to produce oxidative free radicals, triggering a chain reaction of lipid peroxidation and eventually causing the deterioration of fruits and vegetables. Firmness (N) of treated and non-treated samples were carefully monitored within 30 days of storage at 22±2°C in perforated bags. The texture firmness (N) was noticed in table 2. Our results revealed that star apple fruits treated by melatonin 0.30 mmol/L showed the highest firmness (N) retention. There was not significant difference between the samples treated by 0.30 mmol/L and 0.35 mmol/L during 30 days of storage. In control sample, serious decay occurred at the 15th day; the hardness decreased sharply after that. Meanwhile, there was a slight decrease of firmness by melatonin treatment. The fruit was nearly stable until 30th day. Melatonin may influence ethylene to regulate fruit textural changes (Qianqian et al. 2015). Exogenous melatonin can prolong the shelf-life of fruits by preventing fungal infection (Cao et al. 2017). Amin et al. (2019) indicated that melatonin minimized chilling injury of sapota fruit by maintaining membrane integrity, superoxide dismutase and catalase activities and reducing phospholipase D and lipoxygenase activities.

According to Isaac et al. (2015), total soluble solids in pulp of star apple fruit was approximately 11.2°Brix. The reason causing weight loss of post-harvest fruits includes transpiration and the substrate consumption of respiration (Yu and Ren, 2013). In our research, total soluble solid (°Brix) of treated and non-treated samples were carefully monitored within 30 days of storage at 22±2°C in perforated bags. The total soluble solid (°Brix) was shown in table 3. Our results revealed that star apple fruits treated by melatonin 0.30 mmol/L showed the highest total soluble solid retention.

Table 1: Weight loss (%) of star apple fruit treated by melatonin (mmol/L) during storage

Storage (days)	0	5	10	15	20	25	30
Control	0	3.25±0.07 ^a	3.97±0.04 ^a	5.02±0.11 ^a	6.64±0.06 ^a	8.15±0.03 ^a	10.08±0.05 ^a
0.15 mmol/L	0	3.01±0.05 ^{ab}	3.20±0.07 ^{ab}	3.81±0.14 ^b	4.03±0.03 ^b	4.20±0.01 ^b	4.71±0.02 ^b
0.20 mmol/L	0	2.64±0.14 ^b	2.99±0.06 ^b	3.42±0.05 ^{bc}	3.74±0.12 ^{bc}	3.96±0.06 ^{bc}	4.19±0.11 ^c
0.25 mmol/L	0	2.13±0.12 ^{bc}	2.58±0.05 ^{bc}	3.07±0.09 ^c	3.35±0.05 ^c	3.69±0.02 ^c	3.93±0.06 ^{cd}
0.30 mmol/L	0	1.90±0.05 ^c	2.23±0.03 ^c	2.63±0.07 ^{cd}	2.94±0.11 ^{cd}	3.20±0.03 ^d	3.41±0.08 ^d
0.35 mmol/L	0	1.87±0.03 ^c	2.19±0.07 ^c	2.37±0.04 ^d	2.60±0.04 ^d	2.81±0.01 ^e	3.01±0.02 ^e

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

Table 2: Firmness (N) of star apple fruit treated by melatonin (mmol/L) during storage

Storage (days)	0	5	10	15	20	25	30
Control	4.83±0.02 ^a	4.36±0.03 ^c	4.03±0.02 ^c	3.08±0.05 ^c	2.40±0.03 ^d	1.87±0.02 ^d	0.96±0.01 ^d
0.15 mmol/L	4.83±0.02 ^a	4.61±0.02 ^b	4.42±0.01 ^b	4.21±0.03 ^b	4.05±0.01 ^c	3.94±0.02 ^c	3.62±0.03 ^c
0.20 mmol/L	4.83±0.02 ^a	4.70±0.01 ^{ab}	4.58±0.03 ^{ab}	4.39±0.02 ^{ab}	4.27±0.00 ^{bc}	4.12±0.03 ^{bc}	3.98±0.02 ^{bc}
0.25 mmol/L	4.83±0.02 ^a	4.76±0.05 ^a	4.65±0.02 ^{ab}	4.57±0.01 ^{ab}	4.38±0.02 ^b	4.27±0.01 ^b	4.16±0.04 ^b
0.30 mmol/L	4.83±0.02 ^a	4.80±0.02 ^a	4.71±0.00 ^a	4.62±0.04 ^a	4.50±0.01 ^{ab}	4.39±0.00 ^{ab}	4.28±0.01 ^{ab}
0.35 mmol/L	4.83±0.02 ^a	4.81±0.01 ^a	4.79±0.03 ^a	4.66±0.02 ^a	4.61±0.03 ^a	4.50±0.02 ^a	4.37±0.03 ^a

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

Table3: Total soluble solid (°Brix) of star apple fruit treated by melatonin (mmol/L) during storage

Storage (days)	0	5	10	15	20	25	30
Control	12.03±0.01 ^a	11.38±0.02 ^b	10.43±0.01 ^c	9.07±0.03 ^d	7.65±0.02 ^d	6.04±0.03 ^d	5.12±0.00 ^d
0.15 mmol/L	12.03±0.01 ^a	11.79±0.00 ^{ab}	11.25±0.03 ^b	11.04±0.01 ^c	10.83±0.00 ^c	10.30±0.01 ^c	10.04±0.02 ^c
0.20 mmol/L	12.03±0.01 ^a	11.85±0.01 ^{ab}	11.69±0.02 ^{ab}	11.41±0.00 ^{bc}	11.17±0.03 ^{bc}	10.92±0.02 ^{bc}	10.45±0.03 ^{bc}
0.25 mmol/L	12.03±0.01 ^a	11.93±0.03 ^a	11.82±0.00 ^{ab}	11.63±0.02 ^b	11.38±0.00 ^b	11.17±0.03 ^b	10.99±0.01 ^b
0.30 mmol/L	12.03±0.01 ^a	11.98±0.00 ^a	11.90±0.01 ^a	11.75±0.03 ^{ab}	11.64±0.02 ^{ab}	11.39±0.01 ^{ab}	11.15±0.00 ^{ab}
0.35 mmol/L	12.03±0.01 ^a	12.01±0.02 ^a	11.96±0.00 ^a	11.89±0.01 ^a	11.71±0.00 ^a	11.68±0.02 ^a	11.40±0.01 ^a

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

Table4: Vitamin C (mg/ 100g) of star apple fruit treated by melatonin (mmol/L) during storage

Storage (days)	0	5	10	15	20	25	30
Control	11.28±0.03 ^a	11.01±0.01 ^b	10.52±0.02 ^c	10.06±0.02 ^d	9.40±0.01 ^d	8.94±0.00 ^d	7.65±0.03 ^d
0.15 mmol/L	11.28±0.03 ^a	11.09±0.02 ^{ab}	10.91±0.00 ^b	10.63±0.03 ^c	10.35±0.02 ^c	10.17±0.03 ^c	10.01±0.01 ^c
0.20 mmol/L	11.28±0.03 ^a	11.13±0.00 ^{ab}	11.02±0.01 ^{ab}	10.89±0.02 ^{bc}	10.68±0.00 ^{bc}	10.39±0.01 ^{bc}	10.20±0.00 ^{bc}
0.25 mmol/L	11.28±0.03 ^a	11.16±0.01 ^a	11.10±0.03 ^{ab}	10.97±0.01 ^b	10.83±0.03 ^b	10.62±0.00 ^b	10.37±0.02 ^b
0.30 mmol/L	11.28±0.03 ^a	11.20±0.03 ^a	11.17±0.02 ^a	11.04±0.00 ^{ab}	10.95±0.01 ^{ab}	10.81±0.02 ^{ab}	10.63±0.01 ^{ab}
0.35 mmol/L	11.28±0.03 ^a	11.25±0.00 ^a	11.22±0.01 ^a	11.14±0.03 ^a	11.06±0.02 ^a	10.94±0.01 ^a	10.80±0.03 ^a

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

Table 5: Total phenolic content (mg GAE/ 100g) of star apple fruit treated by melatonin (mmol/L) during storage

Storage (days)	0	5	10	15	20	25	30
Control	379.35±1.06 ^a	314.70±0.43 ^b	286.35±3.27 ^c	214.50±2.15 ^d	184.06±1.62 ^d	139.83±2.41 ^d	102.07±1.13 ^d
0.15 mmol/L	379.35±1.06 ^a	351.12±1.39 ^{ab}	329.04±1.43 ^b	304.11±1.87 ^c	287.73±3.26 ^c	261.75±1.65 ^c	247.34±2.07 ^c
0.20 mmol/L	379.35±1.06 ^a	360.43±2.05 ^{ab}	340.67±2.84 ^{ab}	326.50±0.92 ^{bc}	301.09±1.84 ^{bc}	287.40±0.38 ^{bc}	261.19±1.86 ^{bc}
0.25 mmol/L	379.35±1.06 ^a	368.31±0.76 ^a	351.20±3.05 ^{ab}	339.77±1.36 ^b	317.25±3.11 ^b	299.55±2.70 ^b	273.96±1.79 ^b
0.30 mmol/L	379.35±1.06 ^a	372.18±1.49 ^a	360.17±1.71 ^a	346.34±2.74 ^{ab}	331.34±2.08 ^{ab}	312.47±1.99 ^{ab}	298.03±2.34 ^{ab}
0.35 mmol/L	379.35±1.06 ^a	374.06±2.12 ^a	365.94±3.01 ^a	359.22±3.05 ^a	342.69±1.93 ^a	331.24±3.01 ^a	310.24±0.99 ^a

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

Table 6.Total flavonoid content (mg QE/ 100g) of star apple fruit treated by melatonin (mmol/L) during storage

Storage (days)	0	5	10	15	20	25	30
Control	141.27±0.63 ^a	115.42±0.27 ^b	101.21±1.78 ^c	84.73±0.83 ^d	65.20±2.39 ^d	41.79±0.61 ^d	29.18±1.67 ^d
0.15 mmol/L	141.27±0.63 ^a	124.08±0.63 ^{ab}	117.95±2.05 ^b	107.25±1.04 ^c	101.63±0.55 ^c	93.08±0.18 ^c	89.73±0.78 ^c
0.20 mmol/L	141.27±0.63 ^a	129.35±1.42 ^{ab}	121.33±1.60 ^{ab}	113.47±0.33 ^{bc}	107.45±1.61 ^{bc}	99.85±1.34 ^{bc}	95.07±0.93 ^{bc}
0.25 mmol/L	141.27±0.63 ^a	132.84±2.04 ^a	129.42±2.34 ^{ab}	120.63±1.47 ^b	113.26±0.89 ^b	104.61±2.06 ^b	99.34±0.66 ^b
0.30 mmol/L	141.27±0.63 ^a	136.42±1.03 ^a	133.78±1.97 ^a	129.32±0.69 ^{ab}	120.64±1.05 ^{ab}	111.24±1.47 ^{ab}	105.60±1.24 ^{ab}
0.35 mmol/L	141.27±0.63 ^a	139.08±0.74 ^a	136.11±1.30 ^a	132.17±1.38 ^a	125.78±0.33 ^a	119.83±0.78 ^a	112.26±0.37 ^a

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

There was not significant difference between the samples treated by 0.30 mmol/L and 0.35 mmol/L during 30 days of storage. In control sample, dramatical degradation of total soluble solid happened from the 10th day. Meanwhile, there was a slight decrease of total soluble solid in treated samples until 30th day. Exogenous application of melatonin eliminated excess reactive oxygen species from post-harvest fruits and vegetables by increasing antioxidant enzymes, non-enzymatic antioxidants, and enzymes related to oxidized protein repair. Moreover, exogenous application of melatonin could increase endogenous melatonin to augment its effects on various physiological processes (Tao et al. 2019).

According to Oranusi et al. (2015), the vitamin C content in pulp of star apple (*Chrysophyllumcainito*) was around 10 mg/100g. Soluble particles may be degraded as a result of respiration; polyphenol, vitamin C and flavonoid may serve as antioxidant and participate to eliminate free radicals during preservation (Yu Y et al. 2012). In our research, vitamin C (mg/100g) of treated and non-treated samples were estimated within 30 days of storage at 22±2°C in perforated bags. The vitamin C (mg/100g) was elaborated in table 4. Our results revealed that star apple fruits treated by melatonin 0.30 mmol/L showed the highest ascorbic acid retention. There was not significant difference between the samples treated by 0.30 mmol/L and 0.35 mmol/L during 30 days of storage. In control sample, dramatical degradation of ascorbic acid happened from the 10th day. Meanwhile, there was a slight decrease of vitamin C in treated samples until 30th day compared to beginning. Exogenous melatonin can inhibit ethylene biosynthesis and delay the post-harvest deterioration (Tao et al. 2019).

In our research, total phenolic content (mg GAE/100g) of treated and non-treated samples were estimated within 30 days of storage at 22±2°C in perforated bags. The total phenolic content (mg GAE/100g) was presented in table 5. Our results revealed that star apple fruits treated by melatonin 0.30 mmol/L showed the highest total phenolic retention. There was not significant difference between the samples treated by 0.30 mmol/L and 0.35 mmol/L during 30 days of storage. In control sample, strong decomposition of total phenolic content began from the 10th day. Meanwhile, there was a minor change of total phenolic content in treated samples from 20th day. Phenolic substances are the main source of

antioxidants responsible for various biological activities (Bhullar and Rupasinghe, 2015; Lu et al. 2016; İnan et al. 2017).

In our research, total flavonoid content (mg QE/100g) of treated and non-treated samples were estimated within 30 days of storage at 22±2°C in perforated bags. The total flavonoid content (mg QE/100g) was presented in table 6. Our results revealed that star apple fruits treated by melatonin 0.30 mmol/L showed the highest total flavonoid retention. There was not significant difference between the samples treated by 0.30 mmol/L and 0.35 mmol/L during 30 days of storage. In control sample, drastic decrease of total flavonoid content began from the 15th day. Meanwhile, there was a minor change of total flavonoid content in treated samples from 25th day. Melatonin is positively correlated with fruit ripening but is negatively correlated with climacteric fruit senescence (Zhai et al. 2018). Xiu et al. (2019) proved that melatonin treatment increased accumulation of phenol compounds in kiwifruit during preservation (Xiu et al. 2019)

CONCLUSION

Chrysophyllumcainito is a tropical fruit possessing strong antioxidant potentials with multiple advantages to human health. Biodecomposition of star apple fruit prevented its commercial value in post-harvest. A suitable storage technique was essential to extend its quality during distribution. Melatonin has been successfully demonstrated prominent roles in delaying senescence of star apple fruit. This research provided more alternatives for utilization of melatonin to improve the post-harvest preservation of fruits and vegetables.

CONFLICT OF INTEREST

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

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AUTHOR CONTRIBUTIONS

Nguyen Phuoc Minh arranged the experiments and also wrote the manuscript.

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