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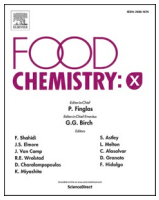

Impacts of exogenous ROS scavenger ascorbic acid on the storability and quality attributes of fresh longan fruit

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ABSTRACT

The impacts of reactive oxygen species (ROS) scavenger ascorbic acid (AsA) treatment on the storability and quality attributes of 'Fuyan' longan fruit were explored. Compared to control samples, the treatment of 4 g L^{-1} AsA solution clearly reduced fruit weight loss, indexes of fruit disease and pericarp browning, retained higher percentage of commercially acceptable fruit, higher values of chromaticity a^*, chromaticity b^*, and chromaticity L^*, delayed pigment degradation in longan pericarp, and retarded the decreases of nutritive ingredients in longan pulp. When stored for 6 d, vitamin C (0.08 g kg^{-1}), sucrose (20.70 g kg^{-1}), total soluble sugar (56.32 g kg^{-1}), and total soluble solids (12.4%) in AsA-treated fruit displayed the clearly higher contents than those in control samples. These data suggested that the treatment of exogenous ROS scavenger AsA could effectively enhance the quality attributes and storability of postharvest longan fruit, thereby lengthen their postharvest shelf-life.

Introduction

Longan is a characteristic *Sapindaceae* fruit that is native to South China and Southeast Asia. Because of its unique flavor, rich nutrients, and high economic value, longan is commercially cultivated in many tropical and subtropical regions and widely consumed in the world (Lin, Lin, Lin, Fan, & Lin, 2021; Tang et al., 2021; Zhang et al., 2020). China is the largest planting area and the highest total yield of longan in the world, longan is widely grown in tropical and subtropical regions of China such as Guangxi, Guangdong, Fujian, Taiwan (Lin et al., 2013). Because of longan fruit ripening in the hot season, they are often troubled by severe postharvest fruit deterioration, such as pericarp browning, disease infection, and fruit senescence (Chen et al., 2021; Chumyam et al., 2016; Lin et al., 2017a, 2020a, 2021; Vichaiya et al., 2020). Under the storage condition of room temperature and without any treatments, postharvest longan fruit normally deteriorate and rot within six days. Such a short shelf-life severely limits the long-distance transportation and the sale of longan fruit. Previous studies demonstrated that low-temperature storage was the most effective method for keeping the quality and enhancing the storability of postharvest longan fruit, which involved rapid pre-cooling, transportation using cold chain system, and storage at low temperature (Holcroft et al., 2005). However, the cost of equipment (cold room, refrigerator cars, and cold chain system) far exceeds the economic bearing capacity of farmers in many planting areas of longan (Holcroft et al., 2005). Furthermore, for the purpose of prolonging storage-life of longan fruit at room temperature, sulfur dioxide (SO_2) fumigation or other chemical antiseptics (such as imazalil, carbendazim, iprodione, and thiabendazole), is usually used for postharvest fresh longan (Holcroft et al., 2005). However, the treatment of fruit with chemicals raises much concern among consumers in many countries including China due to potential health risks. Moreover, many chemical agents are not environmentally friendly and can pollute the ecological system (Jiang et al., 2002). Thus, having a low-cost, safe, and convenient postharvest treatment is crucial to longan postharvest handling and storage.

Previous works found that the decline in quality like disease occurrence and browning of fresh agricultural products was closely interrelated to ROS (reactive oxygen species) accumulation, which promoted membrane lipid peroxidation, thus resulted in the structural breakage of cell membrane, leading to the decline in storability and shortening shelf-life of fresh agricultural produces (Chen et al., 2019; Duan et al., 2011; Lin et al., 2014, 2016, 2017a, 2020a). Whereas, the treatment of pure oxygen (Duan et al., 2011), propyl gallate (Lin et al., 2015), adenosine triphosphate (Lin et al., 2017a), acidic electrolyzed oxidizing water

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(Chen et al., 2019), or chitosan (Jiang et al., 2018a, 2018b) could effectively enhance ROS scavenging capability and subsequently reduce ROS accumulation and production, and thus lengthened shelf-life and enhanced storability of fresh agricultural products.

Ascorbic acid (AsA), without any toxic and side effects, is recognized as an effective antioxidant and is widely used as food additive in food industry to retain colour and pigment stability (Derardja, Pretzler, Kampatsikas, Barkat, & Rompel, 2019; Njus et al., 2020). Additionally, AsA was used as a safe preservative for improving quality and storability of fresh produces (Ali et al., 2021; Lo'ay and EL-Khateeb, 2018; Özdemir, & Gökmen, 2017; Saleem et al., 2021; Sikora, & Świeca, 2018; Song et al., 2019; Zhou et al., 2021). AsA also acts as a powerful ROS scavenger or free radical scavenger (Mahmoud et al., 2013; Njus et al., 2020), however, there is very little document on the application of AsA as a ROS scavenger for harvested fresh agricultural products. So far, the impacts of AsA on the storability and quality of postharvest longan have not been examined. The aim of present work is to study the feasibility of application ROS scavenger AsA for postharvest treatment, and provide a safe, convenient and effective postharvest approach to lengthen shelf-life and enhance quality of fresh longan.

Materials and methods

The material selection and treatments

Commercially mature fruit of longan cv. Fuyan, which the total soluble solids (TSS) content of longan pulp was 18.10% and the chromaticity b^* value of longan pericarp appearance with pale yellow was 29.44, were plucked from Fujian Nan'an longan orchard, China, and transported to our laboratory in Fuzhou. The postharvest longan were selected in uniform maturity, size, shape, and color, afterwards the fruit was rinsed with the sterile distilled water. Afterwards, 150 longan fruit were chosen and served for assessing the fruit properties on the day of harvesting. In addition, 4000 more longan fruit were selected and randomly divided into two groups (2000 fruit per group). These two groups were respectively dipped for 20 min in the distilled water (the control group) or in 4 g L^{-1} AsA solution (the selected AsA concentration of 4 g L^{-1} in this work was based on our preliminary experiment, in which 4 g L¯1 AsA treatment displayed the best outcomes of keeping the quality in postharvest 'Fuyan' longan fruit).

After dipping, all samples were air-dried for 30 min at 25 °C, then AsA-treated fruit and the control fruit were separately wrapped with the bag of polyethylene film (0.015 mm thick) (fifty fruit per bag), hereafter stockpiled for six days at 85 % relative humidity and 25 °C. During storage, at one day interval, three bags of longan fruit were sampled from each group to measure their physiological characteristic, quality indexes and nutritive properties.

Determination of longan pericarp browning index, fruit disease index, and the percentage of commercially acceptable fruit

Fifty fruit were sampled to evaluate longan pericarp browning index, fruit disease index, and the percentage of commercially acceptable fruit referring to the approach of Lin et al. (2020b).

Assessing fruit weight loss percentage

The approach of Lin et al. (2020b) was used for measuring longan fruit weight loss percentage which compared with initial weight of fresh longan.

Analysis of colour parameters of longan fruit

Chromaticity a^*, chromaticity b^* and chromaticity L^* values in longan pericarp were assayed by the approaches of Lin et al. (2017b) and Lin et al. (2020b) with some amendments. Five samples of longan fruit were taken from 50 longan fruit by random. Four evenly spaced points on the equatorial plane in every sample' longan pericarp were analyzed. The values of chromaticity a^*, chromaticity b^* and chromaticity L^* were calculated referring to the previous report of Jiang et al. (2018b).

Determination of carotenoid and chlorophyll content in longan pericarp

Pericarp tissue (1 g) was sampled from 10 longan fruit to analyze the amounts of carotenoid and chlorophyll in longan pericarp based on the approaches of Lin et al. (2020b) and Chen et al. (2015, 2020), and represented as the unit of mg kg^{-1}.

Analyses of contents of longan pericarp flavonoid, total phenolics and anthocyanin

Pericarp tissue (2 g) was sampled from 10 longan fruit to assay the content of flavonoid, total phenolics and anthocyanin in postharvest longan pericarp referring to previous published approach of Lin et al. (2020b). The flavonoid content in pericarp was assayed using the standard of catechin equivalents (CE) with the unit of g CE kg^{-1}. Total phenolics content and anthocyanin content in longan pericarp were measured using the standard of gallic acid (GA) and cyanidin-3-glucoside (C3G), with the unit of g GA kg^{-1} and g C3G kg^{-1}, respectively.

Determination of the contents of vitamin C, titratable acidity (TA) and TSS in longan pulp

Five grams of pulp tissue, 10 g of pulp tissue and 10 g of pulp tissue was sampled from 10 longan fruit respectively to determine the content of longan pulp vitamin C, TA and TSS referring to the approach of Chen et al. (2015). Both TSS and TA contents were expressed as unit of %, and the amount of pulp vitamin C was expressed in unit of g kg^{-1}.

Determination of longan pulp sugar proportion

Pulp tissue (10 g) was sampled from 10 longan fruit to assay the contents of longan pulp reducing sugar, total soluble sugar, and sucrose were measured using the approach of Chen et al. (2020). All results were expressed in unit of g kg^{-1}.

Statistical analyses

Determinations of the possessory indicators were performed three times. All data were expressed as the mean ± standard error. SPSS version 21.0 (SPSS Inc., United States) was applied to analyze the data of experiment.

Results and discussion

Longan fruit disease index, pericarp browning index, fruit weight loss and percentage of commercially acceptable fruit

Previous studies showed that, during postharvest storage of longan fruit, there was a common problem of pathogenic infection by pathogenic fungi (Lin et al., 2017a; Sun et al., 2018). Thus, present work measured the disease index of longan fruit to reflect the degree of infection by pathogenic fungi. As shown in Fig. 1A, the fruit disease index of control samples raised tardily within storage 0–4 d, and then sharply increased during the next two storage days. Whereas, the fruit disease index of AsA-treated samples exhibited a slight increment within storage 0–3 d, and hereafter elevated slowly during the next three storage days. Compare to the control samples, the treatment of AsA could delay the increase of fruit disease index, with a noticeably ($P < 0.01$) lower index of fruit disease on storage days 3, 5 and 6 (Fig. 1A),

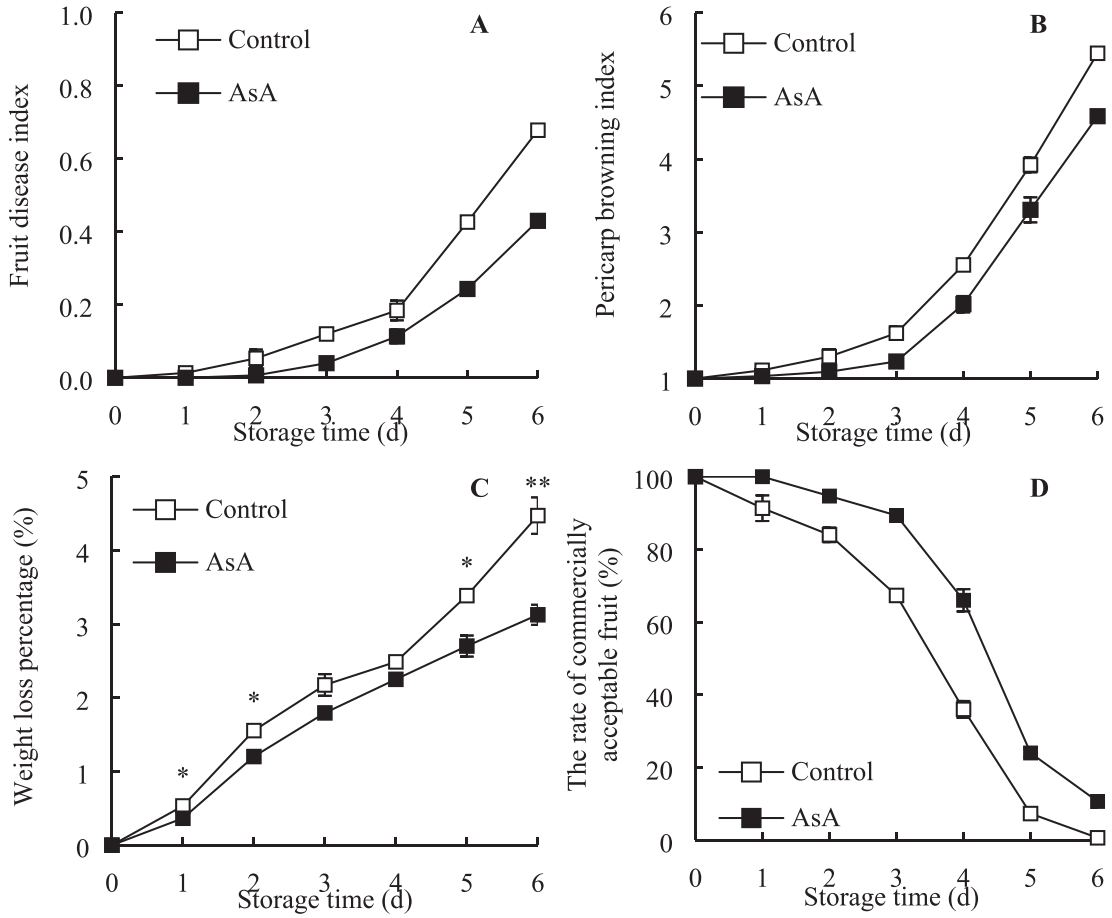

Fig. 1. Impacts of AsA treatment on fruit disease index (A), pericarp browning index (B), weight loss (C) , and rate of commercially acceptable fruit (D) in 'Fuyan' longan fruit during storage at 25 °C for 6 days. Each value is expressed as mean ± standard error (n = 3). □, control; ■, AsA treatment. The mark * and ** represented significantly difference according to the independent samples *t*-test ($P < 0.05$ and $P < 0.01$, respectively) for each storage time.

indicating that AsA treatment was an effective approach to suppress the disease development of fresh longan. These findings were similar to the work of Xylia, Clark, Chrysargyris, Romanazzi, & Tzortzakis (2019), who reported that the treatment of 1% (*w/v*) AsA could remarkably reduce total viable count, and suppress the developments of filamentous fungi and yeasts in shredded carrots during storage.

Browning is another important post-harvest problem leading to unpleasant colour of longan fruit (Holcroft et al., 2005). In this study, pericarp browning index in control group increased mildly within storage 0–3 d, and then displayed a rapid ascent during storage 3–6 d (Fig. 1B). While pericarp browning index in AsA-treated longan ascended slightly within storage 0–3 d, then raised appreciably during the next three storage days. Compared to control group, during storage, AsA-treated fruit kept a lower pericarp browning index (Fig. 1B), indicating that AsA treatment could reduce the progress of pericarp browning of fresh longan.

In harvested fresh vegetables and fruits, the weight loss occurs along with the water loss caused by respiratory processes and transpiration, which seriously affects their quality and appearance including pericarp browning (Zhao et al., 2014). Present work showed that percentage of weight loss (Fig. 1C) in control fruit arose quickly during storage. Analysis of correlation demonstrated that weight loss percentage (Fig. 1C) was positively correlated with pericarp browning index (Fig. 1B) ($r = 0.935$, $P < 0.01$) in control group, indicating that longan pericarp browning was highly interrelated to weight loss. While the weight loss percentage of AsA-treated longan rose slowly, and exhibited a lower weight loss (Fig. 1C) and a lower pericarp browning index (Fig. 1B) when compared to control samples. Further analysis displayed that, compared with control samples, a noticeably ($P < 0.05$) lower weight loss percentage on storage days 1, 2, 5, 6 (Fig. 1C) and a notably ($P < 0.01$) lower pericarp browning index on storage day 4 and day 6 (Fig. 1B) were found in AsA-treated samples. These data showed that AsA treatment could maintain a lower percentage of fruit weight loss, and indicated that AsA treatment for suppressing pericarp browning might be attributed to the reduced weight loss from fresh longan.

The percentage of commercially acceptable fruit usually is a rudimentary estimation whether it can be accepted to consumers. It is assessed according to an existing criterion that no browning or pathogen infection is observed on the surface of postharvest longan (Chen et al., 2015). Present work showed that the fruit commodity rate in control samples decreased slowly within storage 0–2 d, while it dropped rapidly during storage 2–6 d (Fig. 1D). However, the commercially acceptable fruit rate of AsA-treated samples dropped slowly within storage 0–3 d, after that a fast declination was observed during storage 3–6 d. Additionally, an obviously ($P < 0.01$) higher fruit commodity rate was shown in AsA-treated longan than control group during storage 2–5 d (Fig. 1D), indicating that AsA treatment could help to maintain a higher fruit commodity rate of fresh longan.

The above data showed AsA treatment was an effective postharvest method for improving storability and quality attributes of fresh longan.

Longan pericarp colour characteristics

The colour characteristics of postharvest vegetables and fruits are crucial parameters that reflect their quality and commercial grades. Thus, chromaticity a^*, b^* and L^* values could be applied to reflect

accurately the colour of fresh vegetables and fruits, which was a valid approach to show the discrepancy and changes of colour during storage and processing (Wrolstad et al., 2005). Jiang et al. (2018b) indicated that the decrease in redness of fresh litchis was relevant to the declination of chromaticity a^*, b^* and L^* values. In this study, during storage, chromaticity a^*, b^* and L^* values in control samples dropped continuously (Fig. 3A, 3B, 3C), indicating that pericarp superficial colour of longan became darker and less green. However, AsA treatment retarded the decreases of chromaticity a^*, b^* and L^* values. Further analysis showed that a notably ($P < 0.01$) higher chromaticity a^*, b^* and L^* values was displayed in AsA-treated samples than control group at 2–6 d of storage (Fig. 3A, 3B, 3C).

In addition, in control group, the pericarp browning index (Fig. 1B) was conversely related to chromaticity a^*, b^* and L^* values (Fig. 2), with the value of correlation coefficient r −0.802 ($P < 0.05$), −0.934 ($P < 0.01$) and −0.946 ($P < 0.01$), separately. While the rate of commercially acceptable fruit (Fig. 1D) was observably associated with chromaticity a^*, b^* and L^* values (Fig. 2), with value of r 0.981 ($P < 0.01$), 0.917 ($P < 0.01$) and 0.990 ($P < 0.01$), separately.

The findings revealed that AsA treatment maintained higher levels of chromaticity a^*, b^* and L^* values, implying that AsA treatment could help to retain the colour of fresh longan.

Longan pericarp pigment content

The pigments are crucial indicator to evaluate the commercial value and appearance quality attributes of fresh fruits (Jiang et al., 2018b; Lin et al., 2020b). The major pigments in longan pericarp include chlorophyll, carotenoid, anthocyanins, and flavones, which are closely related to the colour change during storage (Lin et al., 2020b).

Fig. 3A clearly displayed that chlorophyll amount in control longan pericarp reduced sharply during storage. However, AsA-treated longan fruit represented a slower decline than control samples, and kept a higher value of pericarp chlorophyll amount with a remarkably ($P < 0.05$) disparity at 1–6 d of storage (Fig. 3A).

Fig. 3B revealed that pericarp carotenoid content in control longan obviously dropped during storage. While a higher amount of pericarp carotenoid could be obviously observed in AsA-treated longan. Further comparison showed that a greatly ($P < 0.05$) higher amount of pericarp carotenoid was observed in AsA-treated group than control samples on storage days 1, 2, 4 and 6 (Fig. 3B).

Anthocyanin is one of important pigments in postharvest vegetables and fruits, and they are beneficial to human health due to their antioxidant capacity (Li et al., 2019; Mullen et al., 2002). In this study, during storage, anthocyanin amount in control longan pericarp dropped promptly (Fig. 3C). However, a higher value of pericarp anthocyanin was shown in AsA-treated fruit, with a dramatically ($P < 0.05$) higher amount of pericarp anthocyanin than control samples within storage 1–6 d (Fig. 3C).

An evident tendency could be easily observed that flavonoid amount in control longan pericarp was promptly reduced throughout the postharvest storage (Fig. 3D). While a dramatically ($P < 0.01$) higher amount of pericarp flavonoid in the AsA-treated longan was shown within storage 1–6 d (Fig. 3D).

Phenols are the most widely distributed secondary metabolites in plants, which are essential for forming the colour and flavor, enhancing ROS scavenging capability, and inhibiting cell membrane lipid peroxidation (Li, Limwachiranon, Li, Du, & Luo, 2016). Present work showed that, during storage, total phenolics amount (Fig. 3E) in control longan pericarp was continuously dropped, whereas the index of pericarp browning (Fig. 1B) increased. Analysis of correlation showed that total phenolics amount (Fig. 3E) was negatively correlated with pericarp browning index (Fig. 1B) (r = -0.943, $P < 0.01$) in control group, indicating that the increased index of pericarp browning might be attributed to the reduction of pericarp total phenolics content. Compared with control samples, an obviously ($P < 0.05$) higher level of pericarp total phenolics at 2–6 d of storage (Fig. 3E) and a lower pericarp browning index on storage days 4 and 6 (Fig. 1B) were shown in AsA-treated group, indicating that AsA treatment restraining longan pericarp browning might be attributed to the reduced oxidation of phenolics.

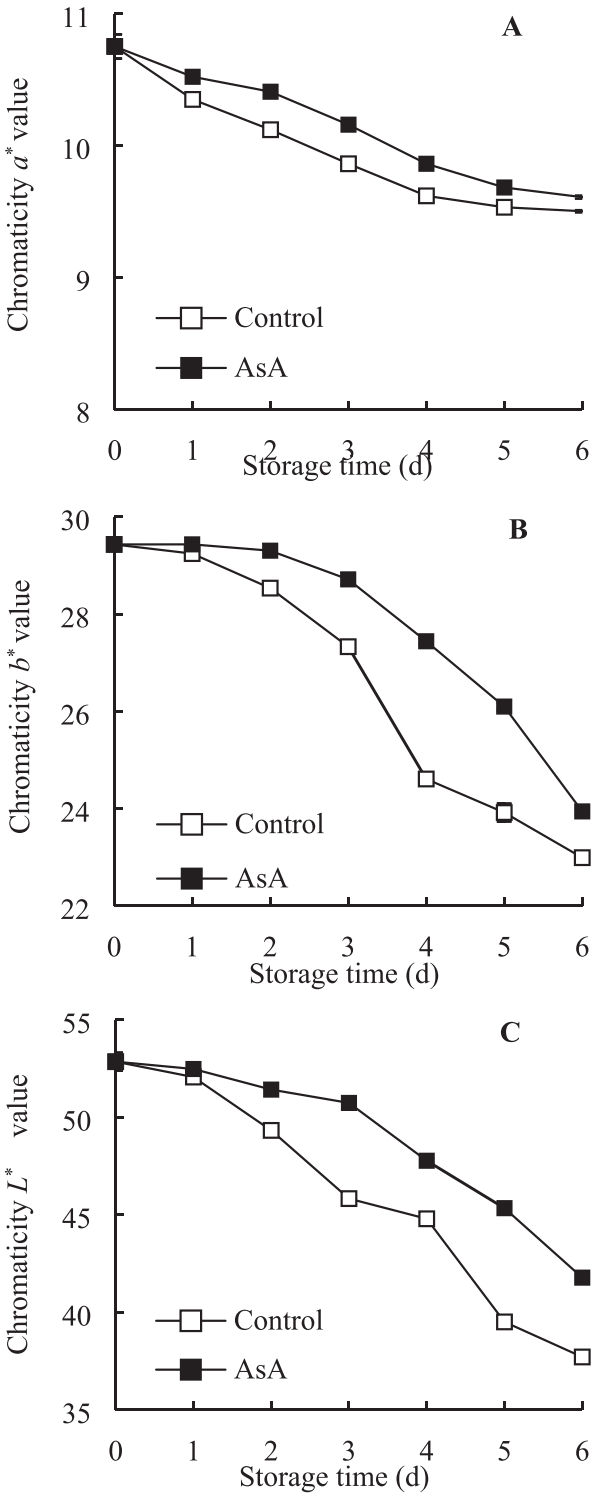

Fig. 2. Impacts of AsA treatment on chromaticity a^* value (A), b^* value (B), and L^* value (C) in pericarp of 'Fuyan' longan fruit during storage at 25 °C for 6 days. Each value is expressed as mean ± standard error (n = 3). □, control; ■, AsA treatment. The mark * and ** represented significantly difference according to the independent samples t-test ($P < 0.05$ and $P < 0.01$, respectively) for each storage time.

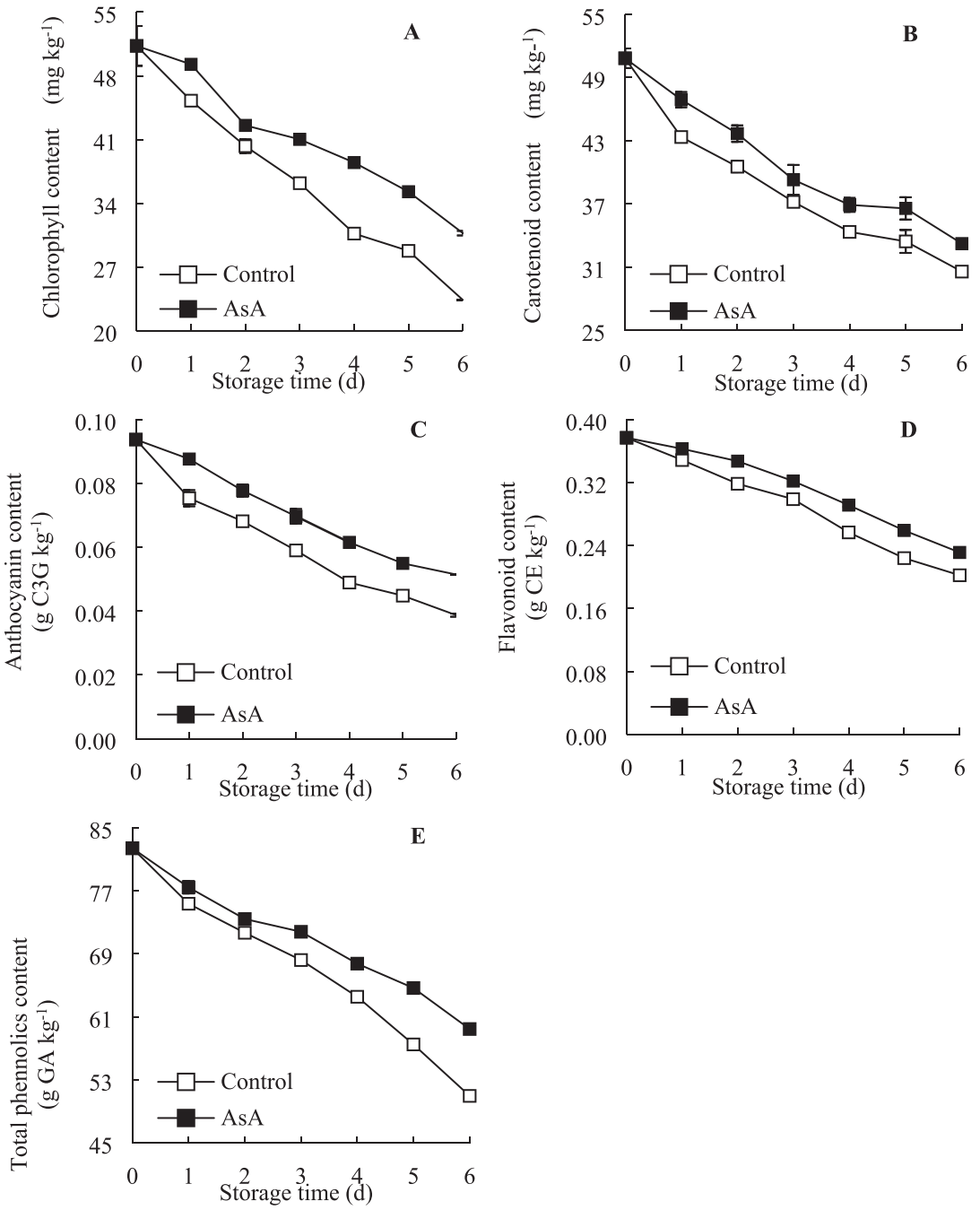

Fig. 3. Impacts of AsA treatment on contents of chlorophyll (A), carotenoid (B), anthocyanin (C), flavonoid (D) , and total phenolics (E) in pericarp of 'Fuyan' longan fruit during storage at 25 °C for 6 days. Each value is expressed as mean ± standard error (n = 3). □, control; ■, AsA treatment. The mark * and ** represented significantly difference according to the independent samples *t*-test ($P < 0.05$ and $P < 0.01$, respectively) for each storage time.

The above data revealed that AsA treatment could help to postpone pigment loss and reduce the occurrence of undesirable colour, which was conducive to sustain a satisfying appearance of postharvest longan.

Longan pulp vitamin C, TSS, and TA contents

Longan fruit has a sweet taste and high sugar content in its pulp. Vitamin C, TSS, and TA are essential components affecting longan taste and nutritional value (Lin et al., 2020b).

Apart from acting as a crucial micronutrient in fruit, vitamin C also acts as an excellent reductant for its scavenging capacity for ROS (Aghdam et al., 2020; Zhao et al., 2014). Present work revealed that vitamin C amount in control longan pulp dropped slightly within storage 0–2 d, hereafter declined slowly during the next four storage days (Fig. 4A). Compared to control fruit, AsA-treated group showed a slower decrease of vitamin C content, and kept a higher vitamin C content. An obviously ($P < 0.05$) higher content of pulp vitamin C was exhibited in AsA-treated longan than control samples at storage 1–6 d except day 5 (Fig. 4A).

TSS include sugars, acids, vitamins, minerals, etc. TSS can be used to measure fruit ripeness and quality. Fig. 4B showed that the amount of TSS in the control group dropped gradually within storage 0–3 d, hereafter declined sharply during the next three storage days. Compared with the control group, AsA-treated group represented a slower decline

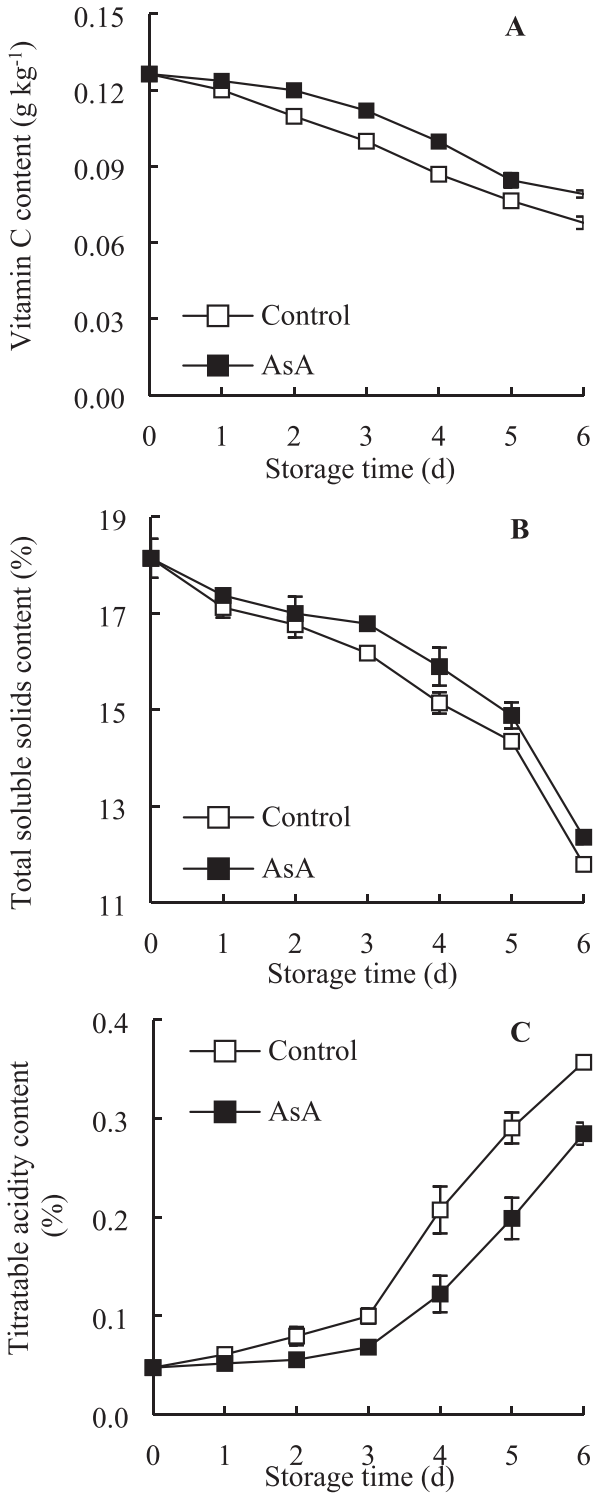

Fig. 4. Impacts of AsA treatment on contents of vitamin C (A), TSS (B), and TA (C) in pulp of 'Fuyan' longan fruit during storage at 25 °C for 6 days. Each value is expressed as mean ± standard error (n = 3). □, control; ■, AsA treatment. The mark * and ** represented significantly difference according to the independent samples *t*-test ($P < 0.05$ and $P < 0.01$, respectively) for each storage time.

of TSS amount, and kept a higher pulp TSS content. A remarkably ($P < 0.05$) higher pulp TSS amount was observed in AsA-treated samples than control group on storage day 3 and 6 (Fig. 4B).

Fig. 4C revealed that the TA amount of control group raised slightly within storage 0–3 d, hereafter elevated rapidly during the next three storage days (Fig. 4C), which might be attributed to the serious sour-rot of longan fruit induced by the infection of *Geotrichum candidum* (Lin et al., 2020b), or an accumulation of organic acid resulting from the elevated tricarboxylic acid cycle and glycolytic metabolism induced by the increase of fruit respiration (Zhao et al., 2014). However, AsA-treated group showed a slower increase of pulp TA content, and kept a lower pulp TA amount than control group during storage (Fig. 4C). Further comparison revealed that a markedly ($P < 0.05$) lower pulp TA amount was displayed in AsA-treated longan than control samples at 4–6 d of storage (Fig. 4C).

These data suggested that AsA treatment could help to maintain lower amount of pulp TA, but retain higher pulp vitamin C and TSS amounts in postharvest longan, which was an effective method to delay the development of longan rancidity and keep the better nutritional attributes. However, the treatment of exogenous AsA may affect the AsA (vitamin C) content in longan pulp. Thus, it is necessary to further estimate the amount of AsA absorbed by longan pulp when longan fruit treated with exogenous AsA.

Longan pulp sugar content

Sugars in fruit include reducing sugar, total soluble sugar, and sucrose. The favorable nutritive performance and flavor of fruit usually depend on the amounts of sugars (Zhao et al., 2014).

Fig. 5A displayed an overall downward trend of pulp total soluble sugar amount in control samples during storage. While a higher level of pulp total soluble sugar was found AsA-treated longan than control group, with a remarkably ($P < 0.05$) disparity during storage 2–6 d (Fig. 5A).

Fig. 5B revealed that pulp sucrose amount of control group declined rapidly within storage 0–3 d, hereafter dropped sharply during the next two storage days, and declined slightly within storage 5–6 d. While AsA-treated group represented a higher amount of pulp sucrose than control longan, with a clear ($P < 0.05$) disparity at storage 1–6 d except day 2 (Fig. 5B).

Reducing sugars are sugars with free ketone or aldehyde groups, such as glucose and fructose (Zhao et al., 2014). Present work demonstrated that reducing sugar amount in control longan pulp increased slowly within storage 0–3 d, hereafter raised quickly during storage 3–4 d, and went up slightly within 4–5 d, but dropped slightly during 5–6 d of storage (Fig. 5C). During storage 3–5 d, the increase of reducing sugar in control samples may be result from the transformation of polysaccharides and sucrose to monosaccharides including glucose and fructose (Lin et al., 2020b). Whereas, the decreased reducing sugar in control samples within storage 5–6 d was because monosaccharides, including glucose and fructose, was used as respiratory substrates for respiration (Chen et al., 2015). Additionally, AsA-treated group represented a lower reducing sugar amount in longan pulp than control group during storage (Fig. 5C). Further comparison revealed that a markedly ($P < 0.05$) lower level of pulp reducing sugar was displayed in AsA-treated longan than control samples at 3–6 d of storage (Fig. 5C).

These data suggested that AsA treatment could help to retain higher contents of sucrose and total soluble sugar, and reduced the transformation of polysaccharides and sucrose to reducing sugar, thus stabilized the flavor and nutritional attributes of harvested fresh longan.

The above-mentioned results suggested that the treatment of exogenous ROS scavenger AsA could help to enhance the storability and quality attributes of postharvest longan, and lengthen their postharvest shelf-life. However, the possible mechanism of exogenous ROS scavenger AsA for enhancing the storability and quality attributes of fresh longan is still unclear. Thus, the mechanism of AsA-improved quality attributes and storability of postharvest longan needs to be further elucidate.

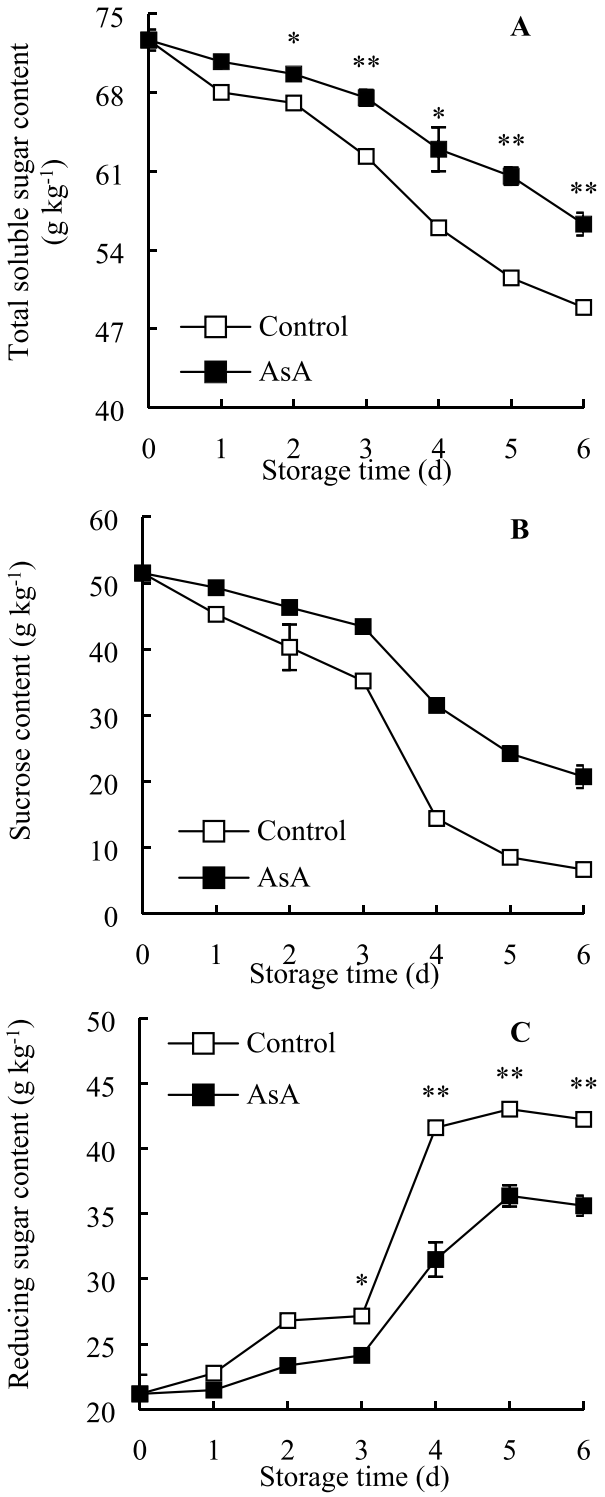

Fig. 5. Impacts of AsA treatment on contents of total soluble sugar (A), sucrose (B), and reducing sugar (C) in pulp of 'Fuyan' longan fruit during storage at 25 °C for 6 days. Each value is expressed as mean ± standard error (n = 3). □, control; ■, AsA treatment. The mark * and ** represented significantly difference according to the independent samples *t*-test ($P < 0.05$ and $P < 0.01$, respectively) for each storage time.

Conclusions

The treatment of exogenous ROS scavenger AsA for longan fruit maintained higher chromaticity a^*, b^* and L^* values in longan pericarp surface, inhibited the decomposition of longan pericarp anthocyanin, flavonoid, carotenoid, chlorophyll, and total phenolics, retarded the occurrence of undesirable colour of longan fruit. Additionally, the treatment of exogenous ROS scavenger AsA for longan fruit retained higher amounts of longan pulp vitamin C, TSS, sucrose and total soluble sugar, but reduced the increments of longan pulp reducing sugar and TA amounts. Furthermore, the treatment of exogenous ROS scavenger AsA for longan fruit reduced longan fruit weight loss, disease occurrence and pericarp browning, but maintained a higher percentage of commercially acceptable fruit. These results demonstrated that ROS scavenger AsA could maintain quality properties in pericarp and nutritional properties in the pulp, as well as exhibit better storable behaviors. Therefore, the application of 4 g L^{-1} AsA provides a practicable post-harvest technique to improve the quality attributes and storability, and thus to prolong postharvest shelf-life of fresh longan.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

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