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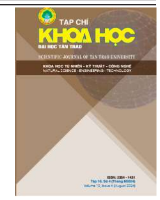

EFFECTS OF ANTIOXIDANTS TO ENHANCE SHELF LIFE OF POST-HARVEST CURTARD APPLE *(nnona squamosa L.)*

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Abstract:

This study evaluates the effectiveness of extending the shelf life of custard apple (*Annona squamosa* L.) harvested in Lang Son through treatment with different antioxidants, including sodium benzoate (SB) 500 solution. and 1000 ppm, ascorbic acid (AA) 500 and 1000 ppm, benzyl adenine (BA) 50 and 100 ppm and stored at cool temperature at 15 ± 20C. The experiment was evaluated based on the parameters of physiological loss in weight (PLW), ripening (%), storage life, spoilage, firmness and total soluble solids (TSS ^{0}Brix). Initial research shows that antioxidants are significantly effective on some post-harvest quality parameters of custard apple, in which post-harvest treatment with BA (50 ppm or 100 ppm) significantly reduce weight loss, slow down physiological ripening time, reduce spoilage rate and increases the storage life of custard apples to 14.5 days compared to only 8.5 days for untreated fruits.

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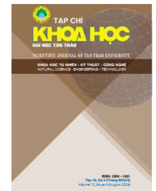

NGHIÊN CỨU ẢNH HƯỞNG CỦA CHẤT CHỐNG OXY HOÁ ĐỂ KÉO DÀI TUỔI THỌ CỦA QUẢ NA *(Annona squamosa L.)* SAU THU HOẠCH

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Tóm tắt

Nghiên cứu này đánh giá hiệu quả kéo dài tuổi thọ bảo quản của quả na (*Annona squamosa* L.) thu hoạch tại Lạng Sơn thông qua việc xử lý với các chất chống oxy hoá khác nhau, gồm dung dịch natri benzoate (SB) 500 và 1000 ppm, axit ascorbic (AA) 500 và 1000 ppm, benzyl adenine (BA) 50 và 100 ppm và được bảo quản ở nhiệt độ mát ở 15 ± 2^0C. Thí nghiệm được đánh giá dựa trên các thông số hao hụt khối lượng quả, độ chín sinh lý, tuổi thọ bảo quản, tỷ lệ hư hỏng, độ cứng và tổng lượng chất rắn hoà tan (TSS ^{0}Bx). Nghiên cứu ban đầu cho thấy chất chống oxy hoá có hiệu quả đáng kể đối với một số thông số chất lượng sau thu hoạch của na, trong đó xử lý bằng BA (50 ppm hoặc 100 ppm) sau thu hoạch đã cải thiện đáng kể giúp giảm hao hụt khối lượng, làm chậm thời gian chín sinh lý, giảm tỷ lệ hư hỏng và kéo thời hạn bảo quản của na lên 14,5 ngày so với những quả chưa được xử lý là 8,5 ngày.

1. Introduction

The curtard apple (*Annona squamosa* L.) has emerged in recent years as a fruit with high economic value. Expanding the cultivation areas for this fruit is considered a solution to restructuring crop systems in many northern mountainous provinces of Vietnam, aimed at improving land use efficiency, exploiting regional potential, and transforming the sugar apple into a branded specialty product in the market.

This study aims to identify which antioxidant can effectively prolong the post-harvest shelf life of sugar apples (*Annona squamosa* L.). The selected antioxidant will then be further studied in terms of concentration and combined with other factors to optimize the preservation duration of curtard apples, thereby facilitating their commercialization in distant markets (Jain et al., 2019).

2. Literature Review

The curtard apple contains significant nutritional value. The edible portion, or pulp, is soft and creamy with a sweet, blended flavor. Every 100g of the edible portion contains protein (1.6 g), fat (0.5-0.6 g), carbohydrates (23.5 g), crude fiber (0.9-6.6 g), calcium (17.6 mg), phosphorus (47 mg), iron (1.5 mg), thiamine (0.075-0.119 mg), riboflavin (0.086-0.175 mg), ascorbic acid (15.0-44.4 mg), and nicotinic acid (0.5 mg) (Jain et al., 2019)

However, the preservation of curtard apples faces many challenges, with post-harvest loss rates averaging between 25-30% (Sahu et al., 2016). The curtard apple is a climacteric fruit, prone to spoilage, and has a very short shelf life (Will et al., 2001). Cold storage is not an effective method for preserving this fruit. If left on the tree for too long, the fruit's skin will split open, accelerating spoilage. Due to its perishable nature, transporting sugar apples to distant markets is difficult. The biggest obstacle to commercializing this fruit lies in its perishability, with an average post-harvest shelf life of only 3 to 4 days at room temperature. This challenge drives up product prices and results in a high spoilage rate, a problem that has yet to be resolved. Therefore, developing technology to extend the post-harvest shelf life of sugar apples is an urgent necessity (Patidar et al., 2021).

Research has shown that antioxidants are molecules capable of preventing or slowing the oxidation of other molecules. These reducing agents prevent oxidation by neutralizing reactive oxygen species before they can cause cellular damage (Halliwell et al.,1989). Several reports have indicated that the use of post-harvest antioxidants, such as benzyl adenine (BA), sodium benzoate (SB), and ascorbic acid (AA), has been effective in reducing weight loss, minimizing spoilage, and extending the shelf life of various fruits, such as mangoes for up to 20 days (Ahmed et al.,1998), papayas for up to 11.33 days (Ravikiran et al., 2007), and guavas for 7 days (Jayachandran et al., 2007). Moreover, the application of SB 500 and AA 1000 ppm post-harvest has been shown by Padmalatha et al., (1993) to effectively reduce weight loss and subsequently increase shelf life.

3. Methods

**** Experimental Setup***

Custard apples (*Annona squamosa*,. L) will be selected based on uniformity in size, firmness, and the absence of pests, diseases, bruises, or mechanical injuries. The fruits will be washed under running water to remove any adhered dirt and then air-dried in the shade.

The surface of the custard apples will be sterilized using a 0.1% bavistin solution for 2 minutes. After that, the samples will be immersed in antioxidant solutions for 10 minutes, consisting of sodium benzoate (SB), ascorbic acid (AA), benzyl adenine (BA), and a control group. Each experiment will be repeated three times with the following treatment formulations:

Formular	Description
CT1	Control
CT2	SB 500ppm
CT3	SB 1000ppm
CT4	AA 500ppm
CT5	AA 1000ppm
CT6	BA 50ppm
CT7	BA 100ppm

After treatment, the fruit samples will be dried and stored at a cool temperature of 15 ± 2°C. The formulas will be monitored for weight loss (%), fruit firmness, total soluble solids (TSS, °Brix), physiological ripening, shelf life, and the decay rate of the fruit. The samples will be measured every two days.

**** Analytical Methods:***

(1) Method for Determining Fruit Weight Loss:

Natural weight loss will be calculated using the formula:

$$X(\%) = (M1 - M2) / M1 * 100$$

Where:

- X is the natural weight loss at each monitoring interval (%),

- M1 is the fruit weight before storage (g),

- M2 is the fruit weight at each monitoring interval (g).

(2) Method for Determining Physiological Ripening and Shelf Life:

Ripening is identified by the appearance of light yellow coloration between the air spaces, light green skin, softness, and a characteristic aroma. The number of ripened fruits is recorded on each sampling day, and the ripening rate is calculated. The number of days required for ripening is determined as the stage when more than 50% of the stored fruits have ripened. Fruit decay is identified through visual observations, such as fungal infection, subsequent rotting, overripeness, cracking, browning, and discoloration.

(3) Method for Determining Fruit Decay Rate:

Fruit decay is identified through visual observations such as fungal infection, subsequent rotting, overripeness, cracking, browning, and discoloration. The number of decayed fruits in each repetition is counted and expressed as the percentage of decay (%). The decay rate is calculated using the following formula:

Decay rate (%) = (B / A) * 100

Where: - A is the total number of fruits monitored,

- B is the number of decayed fruits.

(4) Method for Determining TSS (°Brix):

The total soluble solids (TSS) will be measured using a handheld refractometer.

(5) Method for Determining Fruit Firmness:

Firmness will be measured using the FHT-1122 handheld firmness tester. Fruit firmness is determined by the depth of penetration of the probe into the fruit flesh (mm) under the influence of a specific weight (200g) over a fixed period (30 seconds).

(6) Method for Determining Storage Duration:

The storage period is considered over when more than 50% of the fruits in the sample show signs of decay (are no longer suitable for consumption). This period is expressed in days.

**** Data Processing Method:***

The data is presented as the average result of three repetitions and analyzed using Student's T-test and GraphPad 7.0 software.

4. Results and Discussions

4.1 Effect of Antioxidants on Post-Harvest Weight Loss of Custard Apple

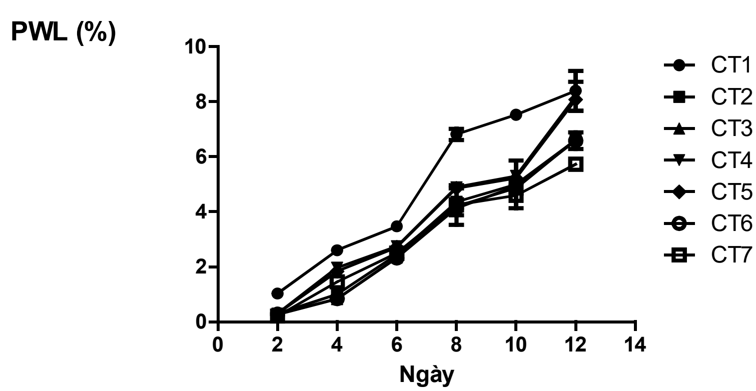

Figure 1. The Effect of Antioxidants on Post-Harvest Weight Loss of Custard Apple

Figure 1 shows that the post-harvest weight loss of custard apples (%) increased over the storage period. However, the weight loss was greatest in the control sample (CT1) on all monitoring days. This indicates that the antioxidant treatments had a significant effect in reducing the weight loss of custard apples after harvest. The least weight loss occurred in the samples treated with 50 ppm BA (CT6) and 100 ppm BA (CT7), with corresponding values of 6.56% and 5.76% on day 12, and the differences were statistically significant compared to the other samples at a significance level of α=0.05. This can be explained by the strong bioactivity of BA, which slows biochemical changes, thereby delaying the ripening process and reducing water loss during storage (Sahu et al., 2016 & Ravikiran et al., 2007). These results are consistent with previous studies, where BA treatment reduced post-harvest losses in curry leaves (Geethalakshmi et al., 2023) and was also reported to minimize weight loss in papaya after harvest (Ramesh et al., 2014).

4.2 Effect of Antioxidants on Physiological Ripening and Shelf Life of Custard Apples After Harvest

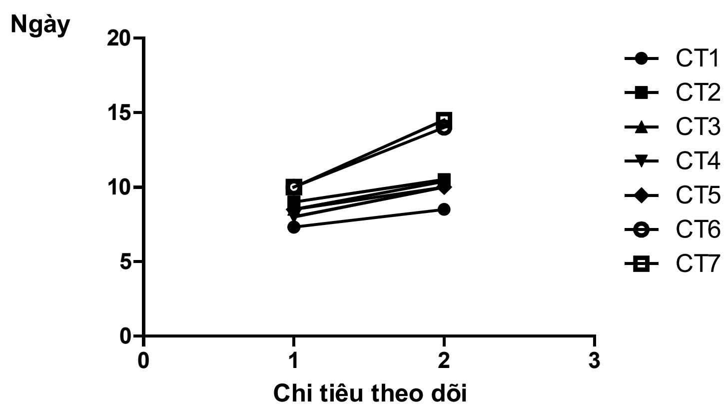

Figure 2. The Effect of Antioxidants on Physiological Ripening and Shelf Life of Custard Apples After Harvest

The post-harvest ripening time of custard apples differed significantly at a significance level of α=0.05. The shortest ripening time was 7.4 days in the control sample, while the longest was 10 days in the samples treated with 50 ppm BA and 100 ppm BA. Custard apples treated with SB and AA reached full ripeness between 8 and 9 days (Figure 2). BA has also been noted to delay ripening in papaya (Ravikira et al., 2007), guava (Jayachandran et al., 2007), and grapes (Padmavathi et al., 2003).

The shortest shelf life was observed in the control sample, indicating that antioxidants extended the storage time of the custard apples. The most significant effect was seen in the samples treated with 50 ppm BA and 100 ppm BA, which had shelf lives of 14 and 14.5 days, respectively—5.5 and 6 days longer than the control sample. According to Ravikiran Reddy (Ravikira et al., 2007), the strong antioxidant activity of BA may slow the ripening process by reducing respiration intensity and ethylene production while acting as a preservative to delay fruit aging. These findings are consistent with previous studies showing that BA, when combined with chitosan and CaCl2, extended the storage life of custard apples (Patidar et al., 2007); prolonged the shelf life of curry leaves by 5 days (Geethalakshmi et al., 2007); extended mango storage by 20 days (Ahmed et al., 2007), and increased papaya storage up to 11.33 days (Ravikira et al., 2007), Jayachandran et al., (2007) reported that applying 25 or 50 ppm BA post-harvest extended the shelf life of untreated guava by 7 days. Padmalatha et al., (2003) found that in grapes, post-harvest application of 500 ppm SB and 1000 ppm AA produced the best results by effectively reducing weight loss and increasing shelf life. Bhagwan et al., (1994) reported that applying 500 ppm SB and 4% wax post-harvest extended the shelf life of bananas (cv. Robusta) at 20°C.

4.3. The effect of antioxidants on the post-harvest quality changes of custard apple

4.3.1 The effect of antioxidants on the change in TSS (°Brix) of post-harvest custard apple

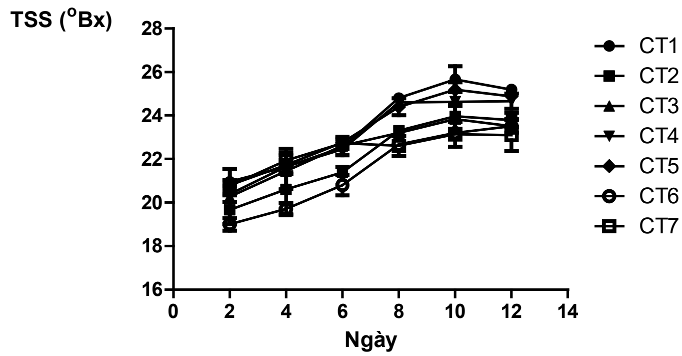

Figure 3. The Effect of Antioxidants on the Change in TSS of post-harvest Custard Apples

The TSS (°Brix) of custard apples increased significantly during storage. TSS in all samples began to rise rapidly on days 6 and 8, peaked on day 10, and then gradually decreased by day 12 of storage. This can be explained by the fact that custard apples are climacteric fruits, meaning that respiration intensity increases to a peak and then gradually declines. This result is consistent with Cheng's study [18] on post-harvest ripening of custard apples.

The TSS (°Brix) increased most rapidly and significantly in the control sample, reaching a peak of 25.67 °Brix on day 10, which is explained by the rapid ripening process [2]. The TSS (°Brix) in the antioxidant-treated samples was lower than in the control, with the lowest values observed in the samples treated with 50 ppm and 100 ppm BA. This could be due to the high bioactivity of BA, which may have slowed the ripening process. These TSS results align with previous studies on delaying ripening in mangoes (Ahmed et al., 2007), and papayas (Ravikira et al., 2007), when treated with 100 ppm BA.

4.3.2 The effect of antioxidants on the change in firmness of post-harvest custard apple

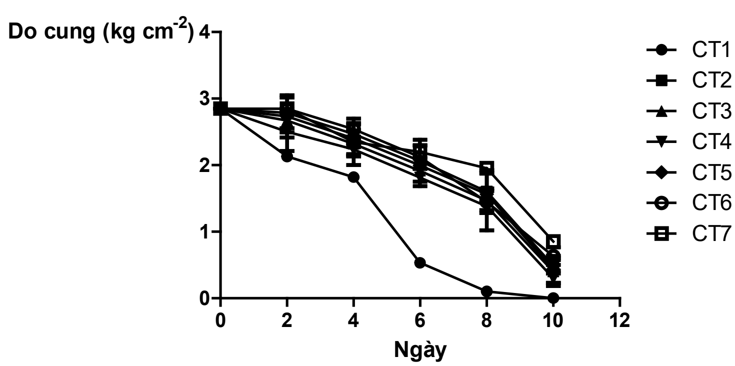

Figure 2. The effect of antioxidants on the ahange in firmness of post-harvest custard apples

Fruit firmness is one of the key physical indicators during storage, determining fruit quality and influencing consumer acceptance. The firmness of custard apples decreased in all samples and dropped significantly from days 8 to 10 of storage. The control sample (CT1) showed a very sharp decline, especially in the last three monitoring days, with firmness reaching 0 kg/cm² on day 10. Higher firmness levels were recorded in the samples treated with 50 ppm and 100 ppm BA, which extended the storage life of the custard apples to 14 and 14.5 days, respectively, while maintaining higher firmness. This finding is consistent with previous studies, where treating guava with 50 ppm BA resulted in higher firmness (Jayachandran et al., 2007).

4.4 The effect of antioxidants on the decay rate of post-harvest custard apple

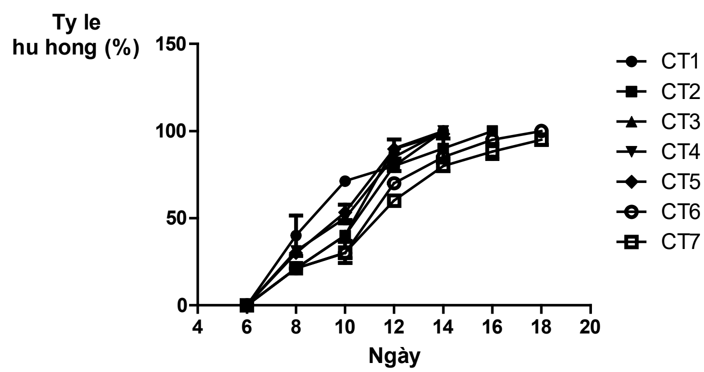

Figure 3. The effect of antioxidants on the decay rate of post-harvest custard apples

The decay rate of custard apples significantly decreased in the samples treated with antioxidants at any concentration before day 10. However, this rate increased sharply by day 12, reaching 100% on day 14 in the control sample and in the samples treated with 1000 ppm SB, 500 ppm AA, and 1000 ppm AA. The only exceptions were the samples treated with BA at both concentrations and 500 ppm SB. The lowest decay rates were observed in the samples treated with 50 ppm and 100 ppm BA (CT6 and CT7), with the sample treated with 100 ppm BA showing complete decay only after 18 days. This could be attributed to BA's strong antioxidant activity, which helps eliminate free radicals and slow the decay process in custard apples. These results are consistent with previous studies, where BA treatment delayed decay in guavas (Jayachandran et al., 2007) and papayas (Ravikira et al., 2007).

5. Conclusion

Based on the current study, it can be concluded that post-harvest application of BA at concentrations of 50 ppm or 100 ppm significantly extended the shelf life of custard apples by 6 days compared to untreated fruit. Treatment with benzyl adenine effectively reduced weight loss and maintained fruit firmness by slowing down the ripening process. Benzyl adenine, an antioxidant and free radical scavenger, may effectively reduce ethylene production, thus delaying the ripening of custard apples in this study. Therefore, future research could explore combining BA with other substances and varying temperature conditions to optimize the post-harvest storage time of custard apples, facilitating transport to more distant markets and enhancing the commercial value of the product.

REFERENCES

Ahmed, M.N., Studies on the Effect of Postharvest Application of Polyamines and Antioxidants on Shelf Life of Mango 'Baneshan', M.Sc. Thesis, Acharya N.G. Ranga Agr. Univ., Hyderabad, India, 1998.

Bhagwan, A, *Studies on Postharvest Handling and Storage of Banana 'Robusta*'. M.Sc. Thesis, Acharya N.G.Ranga Agr. Univ., Hyderabad, India, 1994.

C. Jain, Champawat PS, Mudgal VD, Madhu B, Jain SK, Post-harvest processing of custard apple (Annona squamosa L.): A review, *International Journal of Chemical Studies, 2019,* https://www.researchgate.net/publication/333395243_Post-harvest_processing_of_custard_apple_Annona_squamosa_L_A_review (accessed on: May 31st, 2024).

D. Ramesh, B. Prasanna Kumar, M. Rajasekhar and D.R. Salomi Suneetha, Effect of chemicals and growth regulators on post-harvest shelf-life and quality in papaya (Carica papaya L.) cv. *Red Lady, J. Hortl. Sci. Vol. 9, No. 1, 2014,* pp. 66-73, https://doi.org/10.24154/jhs.v9i1.225.

Geethalakshmi, I. ,Punitha, A., Sumathi, T., Adeline Vinila, J.E., Vadivel, N, Impact of Growth Regulators on Shelf-Life Extension in Curry Leaf (Murraya koenigii Spreng). *International Journal of novel research and development – IJNRD, Vol. 8, No. 3, 2023*, pp. 632-634, http://www.ijnrd.org/papers/IJNRD2303063.pdf.

Halliwell, B. and J.M.C. Gutreridge, Free Radicals in Biology and Medicine 2nd Eds, Clarendon Press, Oxford, UK, 1989, pp. 22-85.

K.S., Jayachandran, D. Srihari and Y.N. Reddy, Postharvest application of selected antioxidants to improve the shelf life of guava fruit. *Acta Horticulturae Journal*, Vol. 735, 2007, pp. 627-632, https://doi.org/10.17660/ActaHortic.2007.735.81.

M. Patidar, J. Kanwar1, O. P. Singh and G. P. S. Rathore, Study on the Effect of Post Harvest Treatments on Shelf Life of Custard Apple (Annona squamosa L.) Variety Arka Sahan during Storage, *International Journal of Current Microbiology and Applied Sciences*, Vol. 10, No.1, 2021, pp. 3159-3164, https://doi.org/10.20546/ijcmas.2021.1001.368.

Padmavathi, C. and Y.N. Reddy, *Role of AOX inhibitors, promoters, polyamines and antioxidants on the biochemical parameters of grape 'Thompson Seedless' during senescence*. Austral. Postharvest Hort. Conf., Brisbane, Australia, 2003, pp. 156-157.

Padmalatha, V., *Studies on Postharvest Storage Life of Grapes (Vitis vinifera L.).* M.Sc. Thesis, Acharya N. G.Ranga Agr. Univ., Hyderabad, India, 1993.

Ravikiran Reddy, Y., *Effect of Gamma Irradiation and Antioxidants on Postharvest Shelf Life of Papaya (Caricapapaya) 'Red Lady'*, M.Sc. Thesis, Acharya N.G. Ranga Agr. Univ., Hyderabad, India, 2007.

Ranganna, S., *Hand Book of Analysis and Quality Control for Fruits and Vegetable Products*. Tata McGraw Hill Pub. Company Limited, New Delhi, India, 1986.

R.K. Sahu, A.K. Agrawal and Geetesh Sinha, Extension of Shelf Life of Custard Apple (Annona squamosa L.) through Post Harvest Treatments, *Madras Agricultural Journal*, 2016, https://www.researchgate.net/publication/373798912_Extension_of_Shelf_Life_of_Custard_Apple_Annona_squamosa_L_through_Post_Harvest_Treatments (assessed on: May 31st, 2024).

Wills, R.B.H., M.A. Warton, D.M.D.N. Mussa and L.P. Chew, Ripening of climacteric fruits initiated at lowethylene levels. *Australian Journal of Experimental Agriculture, Vol. 41, No.1, 2001, pp. 89-92*, https://doi.org/10.1071/EA00206.

Zhihua Cheng, Wei Zhou, Xiao Gong, Xiaoyi Wei, Jihua Li, Zheng Peng, Physicochemical Changes of Custard Apple at Different Storage Temperatures, *IOP Conference Series: Materials Science and Engineering*, Vol. 392, No. 5, 2018, pp. 1-5, doi:10.1088/1757-899X/392/5/052013.