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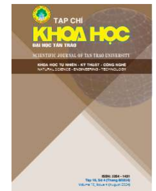

EFFECTS OF BENZYL ADENINE (BA) ON POST-HARVEST QUALITY OF CURTARD APPLE

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Curtard apple, Annona squamosa L., benzyl adenine (BA), storage life

Abstract

This study aims to evaluate the effectiveness of benzyl adenine (BA) on custard apple (*Annona squamosa* L.) fruit (collected in Lang Son) after harvest to prolong storage life. The experiment was treated with BA at different concentrations of 50 ppm, 100 ppm and 150 ppm. Initial research shows that BA was significantly effective in extending the storage life of custard apples through affecting some quality parameters of post-harvest custard apples, including reducing physiological weight loss (PWL), slowing down ripening time, maintaining firmness and reducing spoilage rate. Samples treated at BA 150 ppm showed better results, helping to extend the storage life of custard apple to 6.5 days compared to the control.

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ẢNH HƯỞNG CỦA BENZYL ADENINE (BA) ĐỐI VỚI CHẤT LƯỢNG SAU THU HOẠCH CỦA QUẢ NA

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Từ khóa

Quả na, Annona squamosa L., benzyl adenine (BA), tuổi thọ bảo quản

Tóm tắt

Nghiên cứu này nhằm đánh giá hiệu quả xử lý của benzyl adenine (BA) trên quả na (*Annona squamosa* L.) (được thu hái tại Lạng Sơn) sau thu hoạch nhằm kéo dài tuổi thọ bảo quản. Thí nghiệm được xử lý với BA ở các nồng độ khác nhau 50 ppm, 100 ppm và 150 ppm. Nghiên cứu ban đầu cho thấy BA có hiệu quả đáng kể trong kéo dài tuổi thọ bảo quản của quả na thông qua tác động tới một số thông số chất lượng của quả na sau thu hoạch, cụ thể giảm hao hụt khối lượng, làm chậm thời gian chín sinh lý, giảm tỷ lệ hư hỏng, duy trì độ cứng quả. Mẫu được xử lý ở BA 150 ppm cho hiệu quả tốt hơn giúp kéo thời hạn bảo quản của na lên 6,5 ngày so mẫu đối chứng.

1. Introduction

In recent years, custard apple (*Annona squamosa* L.) has become one of the fruits with high economic value. The development of custard apple cultivation areas is considered a solution to shift the crop structure of many mountainous provinces in the North Vietnam aiming to improve land use efficiency, promoting the potential and advantages of the region, and turning custard apple into a specialty and branded product on the market (Jain et al., 2019).

This study aimed to investigate the preservation effect of BA in extending the shelf life of *Annona squamosa* L. custard apples after harvest. This antioxidant will then continue to be studied in detail in terms of concentration to optimize the storage time of custard apple to effectively commercialize it in many distant markets.

2. Literature Review (Lịch sử nghiên cứu)

The custard apple has many nutritional values. The edible flesh or pulp has a soft, creamy texture and a sweet taste. Each 100g edible part of custard apple 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 g), phosphorus (47 mg), iron (1.5 g), 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).

Preserving custard apple is facing many difficulties. The average post-harvest loss rate of custard apple is very high, ranging from 25-

30% (Sahu et al., 2016). Na is a climateric and perishable respiratory fruit with a very short storage time (Wills et al., 2001). Cool storage is not an effective method for custard apples. If the fruit stays on the tree for a long time, the skin will split and open, allowing the fruit to spoil. Na is a very perishable fruit, so it is difficult to transport it to distant markets. Commercialization of custard apples is the biggest obstacle for growers due to the perishable nature of this fruit. On average, the post-harvest shelf life of this fruit is only 3 to 4 days at ambient temperature. This obstacle causes high prices and high damage rates that have not been overcome. Developing technology to help prolong the post-harvest preservation period of custard apples is required (Patidar et al., 2021).

In many studies benzyl adenine (BA) is used as an antioxidant capable of preventing the oxidation of molecules by removing reactive oxygen species before they can damage cells (Halliwell et al., 1989). Some reports have shown that the use of BA is effective in reducing weight loss, spoilage and increasing the storage time of many fruits such as mango to 20 days (Ahmed et al., 1998) in papaya up to 11.33 days (Reddy et al., 2007) or in guava up to 7 days (Jayachandran, et al., 2007).

3. Methods

Materials: Curtard apple sample was taken from farm in Chi Lang, Lang Son. Selected fruits were harvested after 85 days of fruiting begin, then transported to the laboratory on the same day.

Experimental layout methods

After being harvested, custard apple fruits will be selected that are uniform in size, hardness, free from pests, diseases, and signs of crushing or mechanical injury. The fruit is washed under running water to remove dirt and then left to dry in the shade.

The custard apple will be surface disinfected with 0.1% bavistin solution for 2 minutes. The samples will then be dipped into 50 ppm (T1), 100 ppm (T2) and 150 ppm (T3) benzyl adenine (BA) and the control sample (T0). Each experiment was repeated 3 times.

After processing, the fruit sample will be dried and the fruit stored at a cool temperature of 15 ± 20C. Parameters of physiological loss in weight (PLW), ripening (%), storage life, spoilage, firmness and total soluble solids (TSS ^{0}Brix) were measured every 2 days.

Determination of physiological maturity (days taken to ripening)

Ripeness is determined by the increase in white-yellow color between the trachea, the trachea is light green, soft and has a characteristic odor. Count the number of ripe fruits on each sampling day and calculate the ripeness rate. The number of days required for ripening is determined by the stage when more than 50% of the stored fruit is ripe. Fruit spoilage is determined based on visual observations such as fungal infection and subsequent rotting, overripeness and subsequent cracking, browning and discoloration (Ranganna., S, 1986).

Determination of physiological maturity (days taken to ripening)

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Determination of storage life:

The time when more than 50% of the fruits in the preserved sample are damaged (no longer suitable for consumption) is considered the end of the storage period and this quantity is expressed in units of days (Ramesh, et al., 2014).

Analysis method

The data presented are the average results of 3 repetitions, analyzed by T-test students and Grappad 7.0.

4. Results and discussions

4.1 Physiological weight loss – PWL (%)

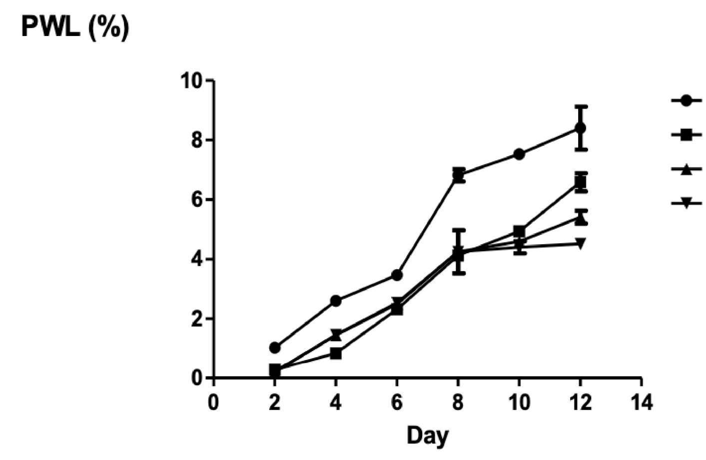

Figure 1. Effect of BA on PLW (%) of curtard apple during storage

Figure 1 shows that the loss of custard apple weight (%) after harvest increased during storage time, however this loss was greatest in the control on 12 days and the difference was significant at α=0.05 with the treament with BA. It seems that BA treaments have an impact on reducing the weight loss of post-harvest custard apple during storage. The strong biological activity of BA helped to slow down biochemical changes, leading to a delay in ripening and dehydration of the fruit during storage (Sahu et al., 2016 & Reddy et al., 2007). This result also corresponds to previous studies where BA treatment reduced post-harvest losses for curry leaves (Geethalakshmi, et al., 2023) and papaya (Ramesh, et al., 2014).

The weight loss of custard apple was the least at 4.52% when treated with BA 150 ppm recorded on day 12, and was significantly different with other treaments of BA 100 ppm and 50 ppm which were 5.41 % and 6.58% respectively. This result is also similar to previous research for treament BA 150 ppm on better effectiveness in delay ripening (Patidar et al., 2021).

4.2 Days taken for ripening and storage life in days

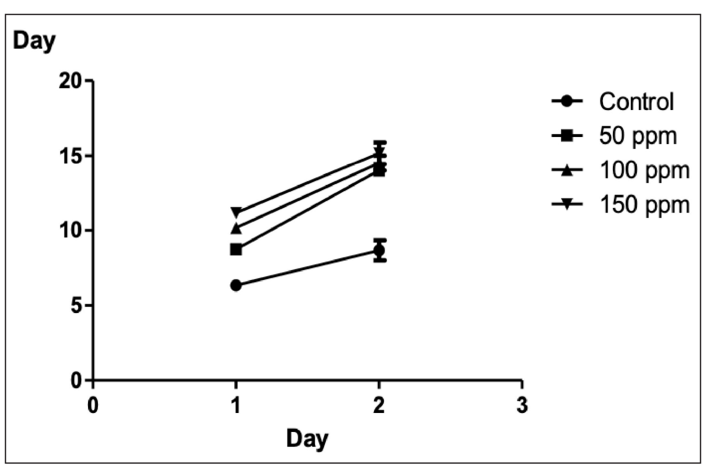

Figure 2. Effect of BA on post-harvest ripening and storage life (days) of curtard apple

The lowest post-harvest ripening time of custard apple in the control is 6.3 days, and the difference is significant at the significance level α=0,05 with treaments with BA. BA has also been reported to delay ripening in papaya (Reddy et al., 20070, guava (Jayachandran, et al., 2007) and grapes (Padmavathi et al., 2003). Na treated with BA 150 ppm slowed down the ripening of custard apple to 11.2 days. This result also corresponds to previous research when this concentration helped slow down ripening for papaya (Ramesh, et al., 2014).

The lowest storage life of custard apple in the control was 8.7 days, showing that antioxidants have the effect on prolonging the storage life of custard apple. The highest efficiency was also recorded 14.5 and 15.2 days for 2 treaments with BA 100 ppm and BA 150 ppm respectively (Figure 2). According to Ravikiran Reddy2 (Reddy et al., 2007) the strong antioxidant activity of BA may have helped slow down the ripening process of the fruit through reducing the intensity of respiration and ethylene, and at the same time acting as a protective agent to prevent the aging process of fruit. This result is also on par with previous studies where BA extended the storage time for custard apples when combined with chitosan and $CaCl_2$ (Patidar et al., 2021); curry leaves for 5 days ; for mango (Geethalakshmi, et al., 2023) for 20 days respectively (Ahmed et al., 1998); for papaya up to 11.33 days (Reddy et al., 2007) grapes and bananas are also effective in extending shelf life when preserved with BA (Padmavathi et al., 2003 & Bhagwan A, 1994).

4.3 Total soluable solids (TSS - ⁰Bx)

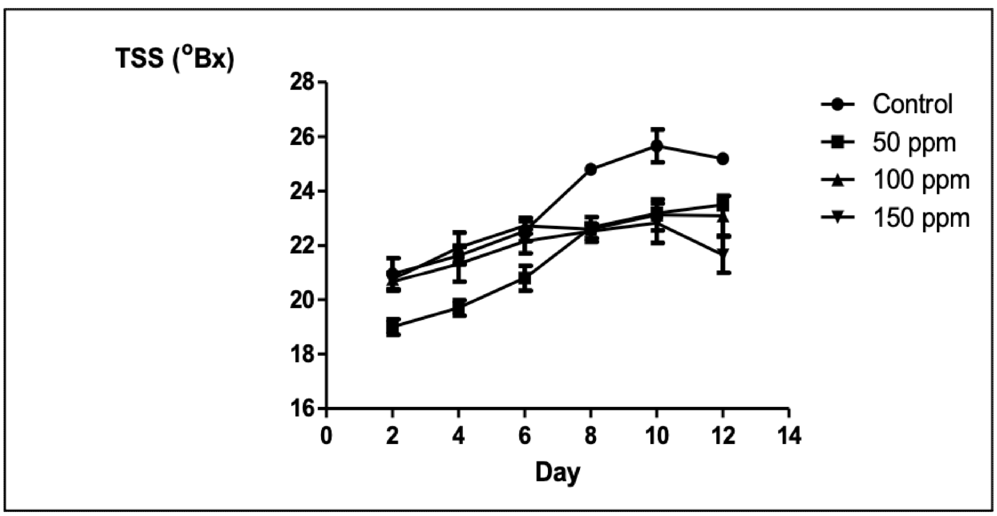

Figure 3. Effect of BA treatment on TSS of post-harvest curtard apple

TSS (⁰Bx) of custard apple increases significantly during storage. TSS started to increase rapidly on days 6 and 8, reached a maximum on day 10 and then gradually decreased on the 12th day of storage. This can be explained because custard apple is a climateric fruit so the respiratory intensity after reaching the maximum will gradually decrease. This result is also similar to Cheng's study on postharvest ripening of custard apple (Cheng et al., 2018).

TSS (⁰Bx) increased rapidly and reached the maximum at 25.7 ⁰Bx in the control on the 10^{th} day of storage, and recored significantly different with all the treaments on the day 12^{th}. It was explained by the rapid ripening process in the control without BA (Sahu et al., 2016)., meanwhile the high biological activity of BA was able to slow down the ripening process for the treatments. These results for TSS are correspond with previous studies as a delay in ripening in mango [6] and papaya leading to lower TSS (Ramesh, et al., 2014 & Reddy et al., 2007).

4.4 Firmness (kg cm^{-2})

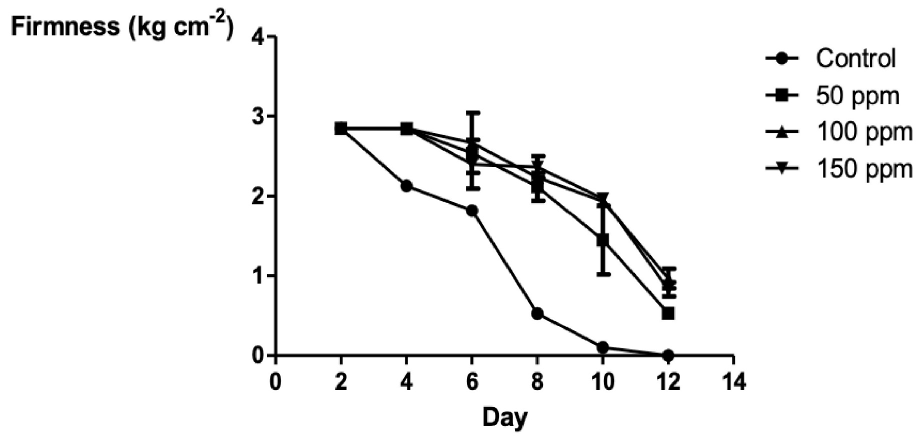

Figure 4. Effect of BA treatment on firmness of post-harvest curtard apple

Firmness is one of the physical parameter during storage, determining the quality of the fruit and affecting its commercial consumption. The hardness of custard apple decreased in all samples and decreased sharply from days 8 and 10 of storage. The control recorded a very strong decrease, especially in the last 3 days of storage and reached a hardness of 0 kgcm-2 on day 10, showing significant differences for all treatment with BA. This implied that BA has an effective effect in slowing down ripening, thereby helping to maintain post-harvest firmness of custard apples.

The hardness of custard apple treated at 50 ppm BA has a significant difference at the significance level α=0.05 with treatments of 100 ppm and 150 ppm. This result is also on par with previous research on papaya treated with 150 ppm BA for higher firmness after 12 days of storage (Ramesh, et al., 2014).

4.5 Spoilage

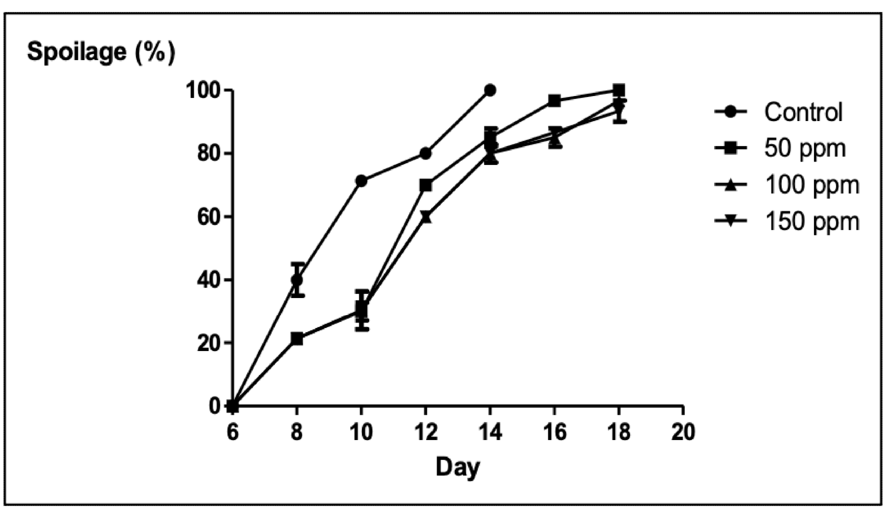

Figure 5. Effect of BA treatment on spoilage of post-harvest curtard apple

The spoilage rate of custard apples decreased significantly in all treatments before the day 10th, but this rate increased sharply on the day 12th. The spoilage rate in the control was 100% on the day 14th and significantlt different at the significance level α=0.05.

On the 16th day, the spoilage rate of custard apple had a significant difference at the significance level α=0.05 between samples T1 to T2 and T3. T1 reached a spoilage rate of 100% on the day 18th. This may be because BA has strong antioxidant activity when treated with custard apples, helping to eliminate free radicals, helping to slow down the deterioration process of custard apples. This result is also similar to previous studies where BA treatment helped slow down damage on guava (Jayachandran, et al., 2007) and papaya Reddy et al., 2007) . On the 18th day, spoilage in T2 and T3 recored was not significantly different, so the two treatments 100 ppm and 150 ppm induced similar effect on curtard apple in term of spoilage.

5. Conclusion

From the research, it can be concluded that application of BA on postharvest custard apples significantly improved the shelf life of the fruit by 6.5 days compared to untreated fruits. BA acts as an antioxidant and helps scavenge free radicals that can effectively reduce ethylene production and thus slow down the ripening process, reducing mass loss and maintaining firmness of fruit. Research also shows that, those treaments with BA 100 ppm and 150 ppm helped the custard apples to preserve longer and deteriorate spoilage (after 18 days). Therefore, this research is highly recommend to expand by combining BA with some other substances and changing temperature conditions to optimize the storage time of post-harvest custard apples, helping them to be transported to further market thereby enhancing the commercial value of the product.

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