EFFECTS OF RETAIN - AVG (AMINOETHOXYVINYLGLYCINE) ON THE STORAGE TIME OF BANANA (MUSA CAVENDISH AAA) AFTER HARVEST

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ABSTRACT

In this study, we investigated the effects of Retain – AVG at different concentrations (0.65 g/l, 0.80 g/l, 0.95 g/l, 1.10 g/l and 0 g/l) in combination with low temperature preservation on banana storage time. The results showed that, at storage temperature of 13^0C, the most suitable concentration of Retain - AVG was 0.95 g/l, resulting in a storage time of 43.6 days compared to 24 days without the use of Retain - AVG. The respiration intensity, firmness, damage rate, total sugar content and total acid content of banana during storage under different conditions have been determined. Results obtained for the best Retain-AVG concentration (0.95 g/l, 13^0C, 24 days) were as follows:

+ Respiration intensity: 5.02 ml CO_2/kg.h (with Retain - AVG) compared to 13.47 ml $CO_2.kg^{-1}.h^{-1}$ (without Retain - AVG).

+ Fruit firmness: 38.13 $N.cm^{-2}$ (with Retain - AVG) compared to 4.65$N.cm^{-2}$ (without Retain - AVG)

+ Total sugar content: 2.98% (with Retain - AVG) compared to 18.13% (without Retain - AVG).

+ Total acid content: 0.29% (with Retain - AVG) compared to 1.25% (without Retain - AVG)

+ Damage rate: 0.91% (with Retain - AVG) compared to 3.63% (without Retain - AVG).

Key words: Retain - AVG, Banana, Ethylene and Ripening.

1. INTRODUCTION

Banana is one kind of the fruit trees grown widely and for a long time in Viet Nam as well as in the world. Among different types of bananas, Musa Cavendish AAA is the most popular because of its nutrient quality, appearance as well as high export value. The aim of this study was to find out how to preserve fresh bananas in order to prolong the post-harvest ripening time. One of the most significant solutions currently applied is the use of ethylene combined with low temperature storage, in which Retain - AVG is considered as the subject of the study. The most important advantage of Retain - AVG is that it can modify the fruit growth, inhibit the biosynthesis of ethylene in fruit and vegetable cells. As a result, it can limit the biological ripening process of the fruits. Consequently, the identification of suitable Retain - AVG concentration for banana storage is the main purpose of this research..

2. MATERIALS AND METHODS

2.1. Materials

Post – harvest banana [Musa sp. (AAA group, Cavendish sub-group)] grown in Nam Dong District, Thua Thien Hue Province was selected for this study. The research was carried out in the fruit and vegetable preservation and processing laboratory, Research Institute of Fruits and Vegetables (Gia Lam, Ha Noi). Banana is harvested after 3 - 3.5 months. Bunches having firm and fat fruits with green skin and bright appearance were chosen. Postharvested bananas are transported directly to the laboratory and the preservation is followed.

Polyethylene bags used for bunches covering are LDPE (low density polyethylene) having the thickness of 25 μm. They were from Vinapacking Company, HCM City, Vietnam.

Carton boxes were made by Packing Company, Thua-Thien-Hue, Vietnam.

2.2. Chemicals

Theophanate methyl (Topsin-M), $C_{12}H_{14}N_4O_4S_2$, was purchased from Nippon Soda Company (Japan). It can be used to kill fungi, especially for apple, pear, grape, banana and cucumber.

Retain – AVG, Aminoethoxyvinylglycine (AVG), $C_6H_{12}N_2O_3$, was purchased from Australia. Retain – AVG can reduce the ripening process and increase the fruit firmness, and as a result, reducing the damage during the shipment.

2.3. Experimental Method and Equipments

Determination of respiration intensity (to measure the CO_2 concentration) is done by CAM – 3 (Anri Instrument and Controls Ltd., Australia) [4].

Measuring the fruit firmness is done by the equipment of Mitutoyo, Japan [4].

Determination of total acid concentration was carried out by neutralization method with NaOH 0.1 N to pH = 8.2 and done by automatic voltage standard equipment 702 SM from Metroohm, Switzerland [2], [4].

Determination of total sugar content is carried out by Bectran method. The general principle of this method is based on the oxydization reaction between sugar and metal ion under alkaline condition [2].

Determination of damage rate: the damaged fruit are the ones which have sights of fungi, black marks with the area of more than 3 cm^2 [7].

2.4. Procedure

Post – harvest banana → shipment → bunch cutting and grading → Topsin-M

Leaving for 3 minutes → Soaking in Retain - AVG solution with formula CT_1, CT_2, CT_3, CT_4 and CTĐC → Leaving for 3 minutes → packing by LDPE 25 μm → Putting in carton boxes → Preserving at 13^0C, air humidity 82 – 85%.

Notes:

CT_1, CT_2, CT_3 and CT_4: banana sample was soaked in 0.65, 0.80, 0.95 and 1.1 g/l Retain-AVG solution at 13^0C, respectively.

CTĐC: Control sample, banana not soaked in Retain- AVG solution and preserved at 13^0C.

3. RESULTS AND DISCUSSION

3.1. Effect of Retain – AVG on insperation intensity of banana during storage

Respiration is a basic biological process occurring in fresh preservation of fruits and vegetables. Organic substances (starches, sugars, organic acids) are dissolved, or is oxydized into new simpler compounds. At the same time energy is freed. However, respiration activity spends a large amount of stored organic substances. So it often creates weight loss and reduces the perceptible quality. The effect of Retain – AVG concentration (g/l) on insperation intensity was described in Figure 1.

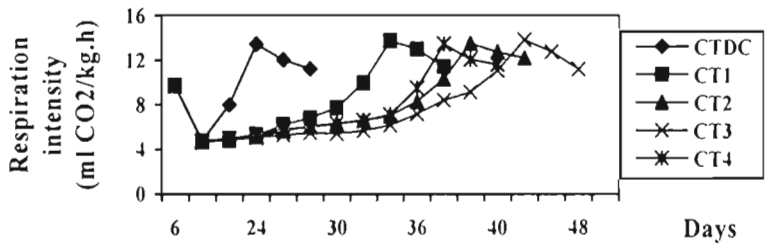

Figure 1. Effect of Retain – AVG on respiration intensity of banana during storage process

After 6 days preservation, the fruit respiration intensity in all samples with or without the use of Retain – AVG went up and reached different maximum values or peaks. The control sample CTĐC has the fastest change of the respiration intensity, which reached a maximum value of 13.47 (ml CO_2/kg.h) on the 24^{th} day. For the samples CT1, CT2, CT3, and CT4, the corresponding values were 34.4, 40, 43.6, and 37.5, respectively . After reaching a maximum value, the respiration intensity went down. This is the time when banana is too ripe and the preservation process ends [3].

Consequently, using Retain - AVG in fresh preservation of banana can inhibit the respiration process, so that the maximum value of respiration intensity will be reached later (13.82 mlCO_2/kg.h of CT_3 on the 43.6^{th} day) compared to the control sample CTĐC (13.47 mlCO_2/kg.h of CTĐC on the 24^{th} day). The experimental results proved that Retain - AVG can reduce the respiration intensity, and so prolong the ripening time of banana after harvest.

3.2. Effect of Retain – AVG on firmness of banana during storage

It is clear that the riper the banana is, the less firm it becomes. The changes of firmness during preservation time with different Retain - AVG concentrations are described in Figure 2.

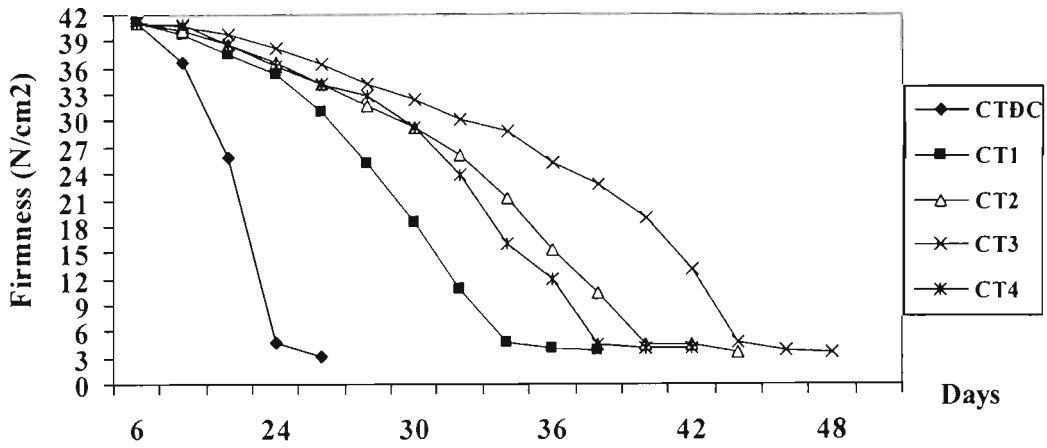

Figure 2. Effect of Retain – AVG on firmness of banana during storage process

Results shown in Figure 2 indicated that the fruit firmness was reduced during preservation time in all samples. The speed of firmness change of the control sample CTĐC is much faster than those of samples using Retain– AVG. In addition, different Retain- AVG concentrations have different fruit firmness changes: the firmness of CT_4 was reduced quickly from the 32nd day to the 37.5th day; sample CT_1 was reduced quickly from the 24th day to the 34.5th day. The reduction of fruit firmness during preservation process is caused by water from banana skin moving into fruit meat, by starches being converted into sugars and destroying the cell walls, and by insoluble protopectin being converted into soluble pectin. Samples CT_2, CT_3 hindered the fruit softening process very well. When the fruit softening process is limited, the fruit damage is slower because the cell structure of fruit skin is also firm. These experimental findings corresponded well with the published results [5], [6].

3.3. Effect of Retain – AVG on some chemical components of banana during storage

The fluctuation (change) of total sugar content, total acid content of banana during the preservation process with or without the use of Retain - AVG is described in Figs. 3 and 4.

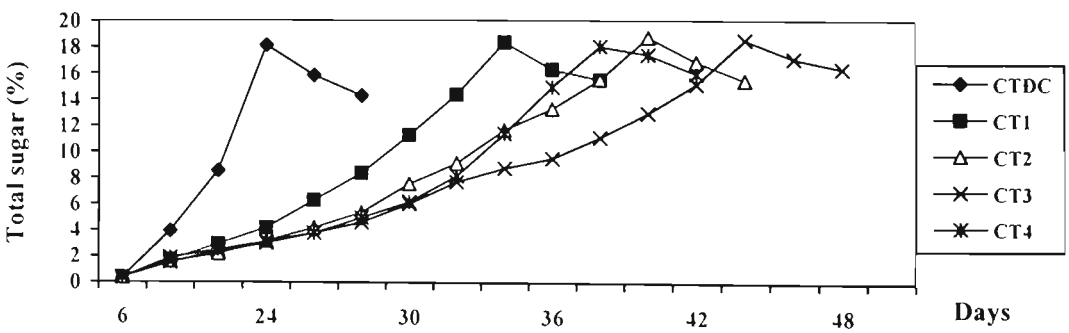

Figure 3. Effect of Retain – AVG on total suger content of banana

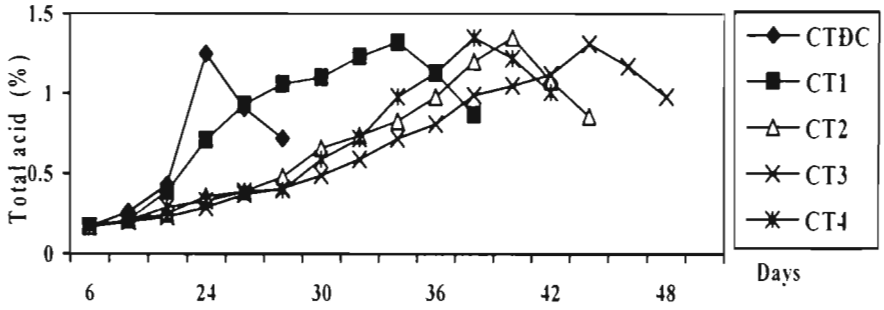

Figure 4. Effect of Retain – AVG on total acid content of banana during storage process

Results shown in Figure 3 and 4 indicated that the sugar and acid content increased more quickly in control sample CTĐC than in samples using Retain – AVG. Samples CT_1, CT_4, CT_2, CT_3 have a gradual change of total sugar and acid content and reached maximum values rather late on the 34.4, 37.5, 40, and 43.6th days, corresponding to their Retain - AVG concentrations.

Consequently, in the fresh storage of banana, the concentration of Retain – AVG used has a reversed effect on the sugar and acid content. This results in prolonging the ripening time.

3.4. Effect of Retain – AVG on the damage rate and storage time of banana during storage

Table 1. The damage rate of fruits in the preservation process

Samples	Storage time (days)	Damage rate
CTDC	**24**	**3,63**
	26	5,46
CT_1	28	6,17
	34,4	**3,45**
	36	4,47
	37,5	5,99
CT_2	**40**	**2,89**
	42	4,14
	43,6	5,39
CT_3	**43,6**	**2,58**
	46	3,57
	48	5,18
CT_4	**37,5**	**3,65**
	40	4,16
	43,6	5,29

The data in Table 1 showed that, at the ripening time, the damaged proportion of CTĐC sample is the greatest. This indicated that the use of Retain-AVG has the effect to inhibit the respiration intensity and to reduce the firmness, total sugar, and total acid content of the fruit. As a result, the damaged rate was reduced, the storage time of banana after harvesting was prolonged as follows:

- At 13°C, the damaged rate of banana without Retain - AVG was 3.63% at the ripening time, the storage time was 24 days.
- At 13°C, the damaged rate of banana with 0.95 g/l Retain - AVG was 2.58% at the ripening time. The storage time prolongs for 43.6 days.

Consequently, the presence of Retain - AVG in the preservation process can increase the firmness, reduce the respiration intensity, the speed of sugar conversion, the total acid as well as the damaged rate of banana. Therefore, the most important meaning of the research was the finding of an effective solution to control and prolong the ripeness of banana after harvesting.

In conclusion, the research has obtained some significant results as follows:

- The respiration intensity, firmness, total sugar and acid content have been determined for banana during preservation process with and without Retain - AVG. Results obtained for the best Retain-AVG concentration (0.95 g/l, 13^0C, 24 days) were as follows:

+ Respiration intensity: 5.02 ml CO_2/kg.h (with Retain - AVG), compared with 13.47 ml CO_2/kg.h (without Retain- AVG).

+ Fruit firmness: 38.13 N/cm^2 (with Retain - AVG) , compared with 4.65 N/cm^2 (without Retain - AVG).

+ Total sugar content: 2.98% (with Retain - AVG) , compared with 18.13% (without Retain - AVG).

+ Total acid content: 0.29% (with Retain - AVG) , compared with 1.25% (without Retain - AVG).

- It was found that the damaged rate of banana was the lowest (0.91%) at the use of Retain - AVG concentration of 0.95 g/l.

- It was found that, combining with storage temperature of 13^0C, the most suitable concentration of Retain - AVG was 0.95 g/l, leading to prolonging the storage time of banana to 43.6 days, in comparison with 24 days when storage was performed without Retain- AVG.

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TÓM TẮT

ẢNH HƯỞNG CỦA RETAIN – AVG (AMINOETHOXYVINYLGLYCINE) ĐẾN THỜI HẠN BẢO QUẢN SAU THU HOẠCH CHUỐI TIÊU *(MUSA AAA CAVENDISH)*

Trong công trình này, chúng tôi đã nghiên cứu ảnh hưởng của chất kháng etylen Retain – AVG (aminoethoxyvinylglycine) ở các nồng độ khác nhau (0,0 – 1,1 g/l) kết hợp với bảo quản ở nhiệt độ thấp đến thời gian bảo quản tươi chuối tiêu. Kết quả nghiên cứu cho thấy, kết hợp với bảo quản ở 13°C, nồng độ AVG thích hợp nhất là 0,95 g/l, cho thời gian bảo quản tươi chuối tiêu kéo dài 43,6 ngày, so với chỉ 24 ngày khi bảo quản ở 13°C mà không sử dụng AVG. Các giá trị về cường độ hô hấp, độ cứng, tỷ lệ hư hỏng, hàm lượng đường và hàm lượng axít tổng số của chuối tiêu trong các quá trình bảo quản đã được xác định. Các kết quả cho chế độ bảo quản có sử dụng AVG (nồng độ AVG 0,95 g/l; nhiệt độ bảo quản 13°C và thời gian bảo quản 24 ngày) như sau:

+ Cường độ hô hấp: 5,02 mlCO_2/kg.h (có sử dụng AVG) so với 13,47 ml CO_2/kg.h (không sử dụng AVG).

+ Độ cứng của quả: 38,13 N/cm^2 (có sử dụng AVG) so với 4,65 N/cm^2 (không sử dụng AVG).

+ Hàm lượng đường tổng số: 2,98% (có sử dụng AVG) so với 18,13% (không sử dụng AVG).

+ Hàm lượng Axít tổng số: 0,29% (có sử dụng AVG) so với 1,25% (không sử dụng AVG).

+ Tỉ lệ hư hỏng: 0,91% (có sử dụng AVG) so với 3,63% (không sử dụng AVG).

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