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Effects of Pre-harvest Application of 1-Methylcyclopropene (1-MCP) on the Postharvest Quality of 'Cavendish' Banana *(Musa cavendishii)*

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Abstract

Several researches have been conducted to investigate the effect of 1-MCP in bananas, but inconsistencies in the results have been reported. Additionally, the effectiveness of 1-MCP is governed by various factors, such as cultivar, fruit maturity, concentration, time of exposure, and method of application. In this study, the effect of pre-harvest methods — Stalk End Immersion (SEI), bunch spraying (BS), Combination (SEI-BS), and Control — of 1-MCP application was determined by observing the postharvest quality of 'Cavendish' bananas, such as peel yellowing, sensory firmness, visual quality, weight loss, degree of shriveling, fruit finger drop, organoleptic attributes, chemical properties, and disease incidence. Results revealed that pre-harvest 1-MCP (aqueous solution dosage of 400 nL/L) application through SEI and SEI-BS methods significantly retarded the peel color change up to 7 days of storage and prolonged the banana's shelf life for up to 19 days under ambient storage conditions. SEI-BS delayed fruit softening (for 15 days) and maintained visual quality (for 19 days) compared to SEI. Fruits treated with 1-MCP through SEI-BS had lesser accumulated weight loss, lower degree of shriveling, and reduced finger drop incidence compared to BS and SEI methods conducted separately. In terms of cost efficiency, BS had lower cost compared to SEI and SEI-BS methods, while the chemical properties, organoleptic attributes, and disease incidence (crown discoloration, crown rot/mold, and banana anthracnose) failed to show any significant difference among pre-harvest methods.

Keywords: ethylene action blocker, stalk end immersion, bunch spraying, peel color change, shelf-life

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Banana (*Musa sp.*) is the common name of the fruit from the herbaceous plants of the genus *Musa*. It is native to tropical regions of Southeast Asia and Australia, and is considered as the most important crop in the Philippines in terms of hectare and commercial value. As a major dollar earner, it ranks first in production and has contributed to more than $100 million annually to the nation's economy (PSA, 2018). On a regional basis, Davao Region is registered as the top producer of banana in the country. Among the varieties cultivated, "Cavendish", the export variety, accounts for 48% followed by "Lakatan'" (30%), "Saba" (11%) and others (11%) (PSA, 2012).

Banana is a climacteric perennial fruit grown and harvested year-round, and is generally harvested in a mature, green state. Generally, bananas are climacteric fruits known for high perishability, short shelf-life, and vulnerability to severe postharvest loss (Basel et al., 2002), estimated at about 3-30% from premature ripening, weight loss, mechanical damage, disease, and rotting (Nuevo and Apaga, 2010). For several years, certain fruits including bananas were classified using the presence or absence of a climacteric increase in respiration during ripening. However, it was also observed that certain features of the ripening process differ among climacteric fruits, particularly the timing of color development in relation to the climacteric peak, which has been changed for some fruits (Laties, 1995; Bower, Holford, Latché, and Pech, 2002).

The "Cavendish" variety is a high value commodity extensively grown for export, and traded internationally through cold container vessels. During shipment, major losses often occur, and these conditions negatively impact the market value of bananas, which contributes to banana quality depreciation and limits export trade (Lassois, De Bellair, and Jijakli, 2008).

Preventing ethylene accumulation around produce is among the approaches used to delay ripening in bananas. In recent years, researchers discovered effective compounds that can control ethylene biosynthesis by Aminoethoxyvinylglycine (AVG), or block production, action, synthesis, or compete for ethylene binding sites by 1-Methylcyclopropene (1-MCP). "1-MCP is a novel compound that can prolong the shelf life of fresh produce by inhibiting the action of ethylene at the receptor level" (Blankenship and Dole, 2003; Watkins, 2006; Nanthachai, et al., 2007) in the tissues of plants, flowers, fruits and vegetables, thus preventing the ripening process (Watkins, 2006; Mir, Canoles, and Beaudry, 2004).

However, while the ability of 1-Methylcyclopropene (1-MCP) to delay ripening in mature-green Cavendish bananas has been evaluated extensively over the years (Joyce, et al., 1999), no study has been conducted on its pre-harvest application for Cavendish varieties even though it has been done for other fruits such as apples and pears (Fan, Argenta, and Mattheis, 1999; Watkins, Nock, and

Whitaker, 2000). Different results influence the effectiveness of 1-MCP, which is governed by various factors, such as crop variety, fruit maturity, concentration levels, time of exposure, and pre-harvest treatments, as well as postharvest handling, storage conditions (temperature and humidity), and length of storage. The interactions of these factors affect the occurrence of physiological disorders among crops (Watkins, 2006). The postharvest application of 1-MCP has been explored, with the gas exposure method cited as the most effective. In bananas, extending the green life has shown significant result, though uneven yellowing during ripening has been observed (Trivedi, 2012).

In this context, it is hypothesized that the pre-harvest application of 1-Methylcyclopropene (1-MCP) can prolong the postharvest quality of banana fruits. 1-MCP delays the expression of ripening attributes and senescence of ethylene sensitive fruits such as bananas by overtaking the binding of ethylene to its receptors, inhibiting ethylene signal transduction and downstream action. This study was intended to determine the effect of 1-MCP application on the postharvest quality of Cavendish banana fruit, as well as to identify the best and most cost-efficient pre-harvest method.

Materials and Methods

The study was conducted in two different sites for field (pre-harvest) and laboratory (storage and chemical) activities following a Completely Randomized Design (CRD). The pre-harvest experiment was conducted at Platero Banana Farm, Santo Tomas, Davao del Norte, while the storage and other laboratory activities were conducted at the Food Technology Laboratory of the University of Southeastern Philippines, Tagum-Mabini Campus, Apokon Unit, Apokon, Tagum City, Davao del Norte. The experiments were conducted from March 20 to April 22, 2019.

Prior to treatment, ten (10) sample plants were identified and tagged in each treatment, with each treatment replicated three times. One week before harvesting, each sample plant was treated based on the following treatments:

T1 – Stalk End Immersion (SEI). The edge of the bunch stalk is immersed in a diluted 400 nL/L of 1-MCP (Figure 1) for two hours.

T2 – Bunch Spraying (BS). An aqueous spray containing 400 nL/L of 1-MCP powder (Figure 1) is sprayed on the bunch stalk.

T3 – Combination (SEI-BS). Stalk End Immersion was done first, followed by bunch spraying. (Figure 1)

T4 – Control. No 1-MCP is applied.

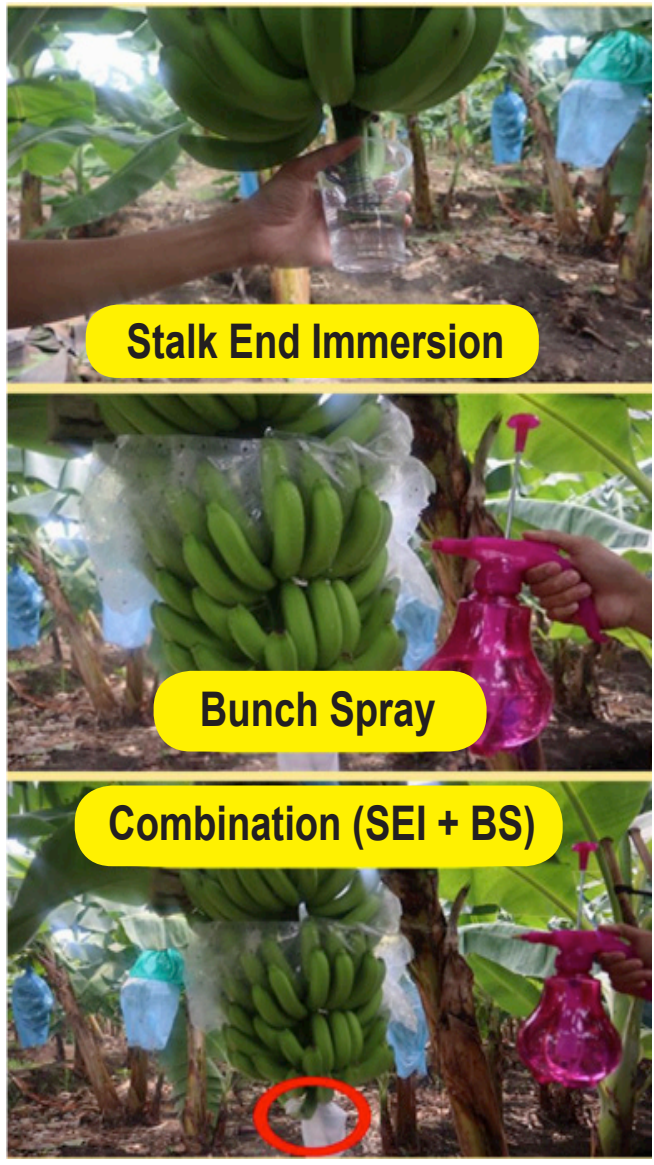

Figure 1. Different pre-harvest methods in applying 1-MCP

Harvesting was done one week after fruit treatment, or 11 hanging-weeks in fruit age. The 2nd to 5th hands, from the distal hand of each bunch, were used for further storage and observation. Each hand was de-handed, clustered, and consequently selected with twelve clusters of "Cavendish" bananas per replicate. The postharvest qualities that were measured include:

Peel color change. This is determined using visual inspection using the banana peel color index 1-7, with 1 referring to green and 7 referring to yellow.

Sensory firmness. This is obtained quantitatively using a hand-held penetrometer. Values are converted to Newton (N), where higher values indicate firmer unpeeled fruit.

Visual Quality Rating. This is determined using a rating scale as follows: 9-8 = excellent, clean skin with no defect/s; 7-6 = good, with minor defect/s; 5-4 = fair, with moderate defect/s; 3 = poor, with serious defect/s; 2 = limited edibility; 1 = non-edible under usual condition.

Accumulated Weight Loss (%). This is measured on a daily basis using a digital weighing scale divided by the initial weight measured before treatment or at Day 0, multiplied by 100.

Degree of Shriveling. This is determined using a rating scale as follows: 1 = 0% or no shriveling, 2 = slightly shriveled; 3 = moderately shriveled; and 4 = severely shriveled.

Finger drop incidence. This is measured by determining the actual percentage of fingers dropped in each cluster.

Total Soluble Solids (TSS), Total Titratable Acidity (TTA), and pH. The fruits used in measuring these chemical properties are those with a peel color index 6. TSS was measured using a hand-held refractometer and pH level was measured using digital pH meter, while TTA was measured through titrimetric method with standard 0.1 NaOH using 0.1% phenolphthalein as indicator.

Organoleptic Attributes. Pulp color, taste, aroma, off-odor, off-flavor, and overall acceptability at peel color indicator 6 were all measured using a scale of 1-10 by a panel of twenty-five (25) evaluators.

Postharvest disease assessment. This was determined using a crown rot rating scale: 1 = 0% or no crown rot; 2 = 1-15% of crown surface affected; 3 = 16-30% of fruit surface affected; and 4 = >30% of fruit surface affected.

Cost of each treatment. The costs of each treatment or pre-harvest method were calculated and compared.

All data were analyzed through Analysis of Variance (ANOVA), and differences among treatments were computed using Tukey's Honest Significant Difference (HSD) test.

Results and Findings

Table 1 shows the various postharvest quality of Cavendish banana fruit as influenced by pre-harvest methods of 1-MCP application over time. In terms of peel color change, fruits treated with 1-MCP through Stalk End Immersion (SEI) and Combination (SEI-BS) consistently manifested a significant delay on peel color change of the fruits compared to control or fruits with no 1-MCP application (Figure 2), as evident on storage days 5 up to 7. Bunch Spray (BS) method also showed comparable results with SEI and SEI-BS methods on delaying ripening from storage days 7 to 15, but reached the maximum peel color change rating on day 17. From this period onwards, the BS and Control treatment groups had already deteriorated, overtaking the other two treatments (SEI and SEI-BS methods).

Significant differences on the firmness of the fruits were also observed among pre-harvest 1-MCP application methods. Fruits with 1-MCP application have firmer pulp than untreated fruits as evident on storage days 9 up to 13. However, on that particular period (day 15), fruits treated with 1-MCP through SEI-BS took more time to start exhibiting signs of fruit softening compared to the other pre-harvest methods.

Figure 2. 'Cavendish' banana fruits at day 4 of storage, where peel yellowing of the control (T4) starts to manifest compared to other fruits with 1-MCP treatment.

Analysis of Variance also showed that pre-harvest methods of 1-MCP application significantly influenced the Visual Quality Rating (VQR) of Cavendish bananas. As manifested on storage days 13 and 15, all fruits with 1-MCP treatment had better VQR compared to fruits without 1-MCP, and among the pre-harvest methods, the SEI-BS method showed better VQR compared to other methods as evident on storage days 17 to 19.

In terms of the accumulated weight loss, data showed that SEI treatments gained the highest degree of weight loss among the pre-harvest methods of 1-MCP application compared to other treatments, as evident on storage day 15 onwards. Though the Control (T4) group registered the lowest degree of weight loss among the treatments, it must be noted these fruits had already deteriorated earlier.

It was also shown that all 1-MCP treated fruits through pre-harvest application had lower degrees of shriveling compared to control, as evident on days 9 to 15. Stalk End Immersion (SEI) and Combination (SEI-BS) had better results, as evident on days 13 and 17, but the latter had better result on days 15 and 19. On the other hand, SEI gained the highest finger drop incidence while Combination (SEI-BS) treatments had the lowest fruit drop incidence among other treatments/methods, as manifested on day 17.

Table 1. Postharvest quality of 'Cavendish' banana fruit as influenced by methods of 1-MCP application.

Parameters[1]	Days of Storage									
	Day 1	Day 3	Day 5	Day 7	Day 9	Day 11	Day 13	Day 15	Day 17	Day 19
A. Peel Color Change	ns	ns	**	**	**	**	**	**	**	ns
SEI	1.00	1.76	2.45 a	4.00 a	4.11 a	4.70 a	5.18 a	5.84 a	6.32 a	6.98
BS	1.00	1.86	3.23 b	4.27 ab	4.33 a	4.81 a	5.33 a	6.14 a	7.00 b	7.00
SEI + BS	1.00	1.76	2.36 a	4.00 a	4.09 a	4.64 a	5.08 a	5.73 a	6.28 a	6.83
Control	1.00	1.81	3.39 b	4.52 b	4.83 b	5.79 b	7.00 b	7.00 b	7.00 b	7.00
B. Sensory Firmness (N)	ns	**	*	*	**	**	**	**	ns	ns
SEI	47.99	30.22 b	23.80 ab	21.55 ab	18.29 b	13.95 a	5.29 a	2.51 b	1.62	1.62
BS	48.07	28.92 c	23.24 b	21.58 a	19.73 a	13.37 a	3.08 b	1.38 c	1.38	1.38
SEI + BS	48.12	31.28 a	24.11 a	21.28 ab	15.10 c	11.73 b	5.70 a	3.79 a	1.87	1.54
Control	48.63	28.65	23.48 ab	20.20 b	3.81 d	1.89 c	1.89 c	1.89 c	1.89	1.89
C. Visual Quality	ns	ns	ns	ns	ns	ns	**	**	**	**
SEI	9.00	7.75	7.67	4.46	4.46	4.00	3.84 a	3.42 a	1.82 b	1.00 b
BS	9.00	7.75	7.44	4.19	4.19	4.11	3.61 a	3.00 a	1.00 b	1.00 b
SEI + BS	9.00	7.73	7.56	4.42	4.42	4.00	3.86 a	3.52 a	2.79 a	2.11 a
Control	9.00	7.79	7.61	4.23	4.23	3.83	1.00 b	1.00 b	1.00 b	1.00 b
D. Accumulated Weight Loss (%)	ns	ns	ns	ns	ns	ns	ns	*	**	**
SEI	1.34	3.55	4.10	4.76	5.68	6.38	8.63	16.38 b	22.21 b	22.21 b
BS	1.42	3.76	4.71	5.47	7.05	7.88	9.18	11.03 a	11.03 a	11.03 a
SEI + BS	1.32	3.54	4.04	4.68	5.44	6.04	8.29	8.90 a	10.85 a	10.85 a
Control	1.31	3.49	4.18	4.88	6.30	6.30	6.30 a	6.30 a	6.30 a	6.30 a
E. Degree of Shriveling	ns	ns	ns	ns	**	**	**	**	**	**
SEI	1.00	1.00	1.00	2.00	2.00 a	2.00 a	2.03 a	2.23 b	2.46 a	3.00 b
BS	1.00	1.00	1.00	2.00	2.00 a	2.00 a	2.20 b	2.58 c	3.00 b	3.00 b
SEI + BS	1.00	1.00	1.00	2.00	2.00 a	2.00 a	2.00 a	2.07 a	2.37 a	2.60 a
Control	1.00	1.00	1.00	2.00	2.22 b	2.89 b	3.00 d	3.00 d	3.00 b	3.00 b
F. Finger drop incidence (%)			ns	ns	ns	ns	ns	ns	*	ns
SEI	-	-	3.29	3.29	3.29	3.29	3.29	4.03	7.37 c	7.37
BS	-	-	3.12	3.12	3.12	3.12	3.12	4.91	4.91 b	4.91
SEI + BS	-	-	1.61	1.61	1.61	1.61	1.61	1.61	2.04 a	6.42
Control	-	-	4.01	4.01	4.01	4.51	4.51	4.51	4.51 ab	4.51

1 - means with the same letter do not differ significantly at 0.05 level using Tukey's HSD test; ns denotes not significant; * denotes significant; ** denotes highly significant.

The TSS, TTA, and pH of Cavendish banana fruits showed no significant interaction among pre-harvest methods of 1-MCP application based on the statistical result of Analysis of Variance. The numerical difference of these parameters (TSS, TTA, and pH) with respect to the pre-harvest application of 1-MCP was only slight. In terms of organoleptic attributes of the fruits, the results revealed no significant effect among treatments. Similarly, results on the disease development of the fruits in terms of crown discoloration and crown rot/mold

development also failed to show any significant difference. It was also noted that there was no anthracnose incidence recorded throughout the observation period. The pre-harvest methods of 1-MCP application on Cavendish banana fruits did not favor anthracnose development.

Discussion

This study was conducted to determine the effect of 1-MCP applied as pre-harvest treatment on the postharvest qualities of Cavendish bananas, as well as to identify the best pre-harvest method of 1-MCP treatment and the most cost-efficient method.

"1-Methylcyclopropene (1-MCP), a novel gaseous anti-ethylene compound, has shown an immense benefit for controlling the ripening and senescence of a number of fruits" (Blankenship and Dole, 2003; Watkins 2006; Hyber, 2008 as cited in Rahman, et al. 2014) (climacteric fruits), including bananas. However, limited studies had been conducted on the use of 1-MCP through pre-harvest application, since most researchers utilized 1-MCP as postharvest treatment. In postharvest researches, results have shown that 1-MCP significantly delayed the physiological and chemical processes of the fruit which considerably affect the quality of the produce.

This present study has shown that the temperature and relative humidity reading during storage correlates with the ripening behavior of Cavendish fruit as demonstrated by faster deterioration of untreated fruits. This is evidenced by changes in the fruits' physical and physiological changes being studied, manifested by the acceleration of ripening attributes' expressions. Pauling (1988) elucidated that for many common chemical reactions at room temperature, the deteriorative reaction rate doubles for every 100°C increase in temperature. This historically useful generalization is supported by the formula for the temperature dependence of reaction rates, known as the Arrhenius' equation (Arrhenius, 1889).

Peel color change

Color change of the peel is an important indicator of ripeness of bananas. In this study, the peel color change of Cavendish bananas was influenced by pre-harvest application of 1-MCP as evidenced by the aforementioned results and findings. This outcome proved another evidence on the efficacy of 1-MCP in delaying the peel color change in bananas. This delay corroborated with the studies conducted by several authors (Manigo and Limbaga, 2019; Trivedi,

2012; Kesari, Trivedi, and Nath, 2007); these researches nonetheless were conducted through postharvest application of 1-MCP remarking gas exposure as the most effective method of 1-MCP application in delaying peel color change.

In addition, temperature and relative humidity (RH) played an important role in the peel color change of Cavendish fruits. Those without 1-MCP treatment changed in color sharply, given the storage temperature range of 26 – 29°C and RH of 76 – 86%, which were conducive for physiological and chemical activity of most climacteric fruits.

It was further shown in this experiment that Stalk End Immersion (SEI) and Combination (SEI-BS) methods had better results in delaying the peel color change of Cavendish bananas. The commendable result of the SEI method can be associated with the source-sink relationship concept in crop plants (Venkateswarlu and Visperas, 1987). *Source* refers to the potential capacity of stalk to absorb water and other dissolved minerals, while *sink* is the potential capacity of fruits to utilize those. As the 1-MCP is taken up, it will irreversibly bind with the ethylene receptors of green bananas. Ripening will still occur the moment new ethylene receptors will be synthesized, after which ripening attributes will begin to manifest.

Sensory firmness

Fruit softening is an important quality parameter of most fruits, including bananas. Based on the results of this experiment, Cavendish bananas treated with 1-MCP delayed the softening of the fruit compared to 1-MCP untreated fruits, with softening significantly affected by storage temperature and concentration of relative humidity. As the 1-MCP-treated fruits delayed their peel color change under ambient condition, softening was likewise delayed as evidenced by firmer pulp compared to fruits without 1-MCP treatment. Green peel was held until 13 storage days, in concurrence with the delay of fruit softening. These conditions favor international trade especially on cases of SGRT (Soft Green Ripened Tolerance), a condition where banana appears green but has soft pulp.

The softening of bananas also associated with the changes in the chemical components of the fruit as it ripens. A study conducted by Kojima in 1996 suggested that the decrease in elasticity and in viscosity of the pulp of bananas are major physical components of pulp softening. The results of his chemical analysis show that the partial breakdown characterized by a decrease in arabinose, mannose, and galactose contents in the hemicelluloses of the cell wall preceded the breakdown of starch. These further suggest that the associated process where the decrease in the contents of pectic and hemicellulosic polysaccharides and

starch is the main cause for the pulp softening process.

Stalk End Immersion also showed promising results in delaying the softening of fruits, which coincides with the delay of peel color change. The absorption potential of the stalk end of bananas enhances the binding of 1-MCP in the ethylene receptors of green bananas.

Visual Quality

The visual quality of fruits is an important market requirement of bananas as it limits marketability and influence customer preference. While 1-MCP loses its visual quality over time under ambient storage, this can be improved through storage at lower temperature to inhibit growth of postharvest pathogens. In some cases, the visual quality of 1-MCP-treated fruits is associated with higher incidences of external blemishes in papaya and custard apple (Hofman, et al., 2001). Wooliness and reddening of nectarines were more prominent in 1-MCP-treated fruits compared to untreated controls (Dong, Lurie, and Zhou, 2002). Fan et al. (2000) reported no quality problems in apricots when treated with 1-MCP. Likewise, plum quality was not adversely affected by 1-MCP treatment (Dong et al., 2002).

Accumulated Weight Loss

Fresh produce, including bananas, continue to lose water and shrink post-harvest. This quality parameter is essential in the value chain of bananas as the loss of weight can be equated with the loss of economic opportunity. In this study, 1-MCP may reduce or have no effect on fruit weight loss according to the species. While 1-MCP did not affect weight loss in some non-climacteric fruits such as oranges (Porat, et al., 1999), it delayed weight loss in climacteric fruits including avocado (Jeong, Huber, and Sargent, 2002). Weight loss could also be indirectly reduced by the action of 1-MCP on respiration (Sisler and Serek, 1999).

Peel Shriveling and Finger Drop Incidence

The lesser degree of peel shriveling of Cavendish banana fruits treated with 1-MCP could be attributed to the weight loss of the fruit. As the fruit suffers the consequence of substantial weight loss during prolonged storage, the peel loses moisture and eventually shrivels (Singh and Sharma, 2007), and the falling off of the fingers, technically known as “finger drop”, is due to the peel rupturing at the pedicel. Normally, senescent spots in banana become visible at the

late stages of ripening, i.e., during or beyond the full yellow stage (PCI 6). However, in the study of Salazar and Serrano in 2013, they reported that minute brown spots on peel were already evident on 'Cuarenta dias', a variety of banana, at PCI 4. Hence, as ripening progressed, senescent spots at the ventral side of the fruit near the pedicel-end coalesced and formed a short, narrow dark-brown band (0.5–1.0 cm long and 0.1–0.2 cm wide), resulting in a partially broken peel appearance. The peel crack was further enlarged, and with time, the partially broken peel (crack) acted like an abscission band from which the finger and the pedicel separated.

The presence of peel crack consistently resulted in finger drop within the next 24-hour period, suggesting that it is a morphological marker of the salient changes in peel composition and properties that predispose the fruit to finger drop.

The commercial ripening of bananas occurs at a high relative humidity, which prevents the browning of damaged skin areas. In experiments with ripening at high RH (94 ± 1%), the individual fruit (fingers) of 'Sucrier' (Musa acuminata, AA Group) banana exhibited a high drop rate. The fingers' falling off is due to the peel rupturing at the pedicel. In contrast, if the fruit was held at low RH, (68 ± 3%) finger drop was absent (Saengpook, Saichol, and Doom, 2007).

Chemical Properties

Total soluble solids (TSS), total titratable acidity (TTA), and pH of fruits were measured at full yellow stage (PCI 6). These parameters are important indicators of fruit quality. The balance of sweetness and acidity determines the quality of taste, which affects consumer acceptability.

In this study the chemical properties were comparable among all treatments, though it is noteworthy to mention that these samples per treatment were not taken at the same time. Banana fruits with no 1-MCP treatment (control) were collected with samples for chemical analysis earlier than fruits with 1-MCP treatment since these fruits already reached PCI 6 at day 11 as compared to fruits with pre-harvest application of 1-MCP. This further proved that fruits treated with 1-MCP preserved not only the green stage but the chemical properties as well.

Organoleptic attributes

The outcome of the organoleptic attributes of Cavendish bananas could be attributed to the fruits' number of storage days. As 1-MCP-treated fruits held the ripening expression, the chemical changes were also delayed, as well as the alteration of the organoleptic attributes of the commodity.

This is comparable with the results of a study by Ramkrishan and Godara (1993), where during prolonged storage, there was a noted decrease in fruit firmness, specific gravity, and organoleptic quality, with a corresponding increase in fruit acidity. In terms of weight loss percentage, a recorded fruit weight loss of 10.4% in the case of Indian Jujube cv. 'Umran' was still organoleptically acceptable after 12 days, but weight loss was more than double under ambient temperature (24.1%) (Fageria, et al., 1999; Dhaka, et al., 2000).

During the normal ripening process, as chlorophyll in the peel breaks down, the starch within the fruit is converted into simple sugars. As a result, the peel turns yellow, and the fruit softens and becomes sweet. This change leaves the peel softer and thinner, making it much easier to "peel" back from the pulp (Müller and Kräutler, 2010). However, when the ripening process is delayed, such as in the case of 1-MCP treated fruits, the conversion of sugar also slows down. The pH decrease and titratable acidity increase also slows down, affecting flavor (Kulkarni and Aradhya, 2005).

With these, 1-MCP treated fruits have lower sensory attributes due to the delay in the conversion of starch to sugar, as well as the delay in attaining an acceptable sugar and acid balance.

Postharvest diseases

Postharvest diseases are economically important as this affects various quality considerations. In this study, the development of crown rot, crown discoloration, and anthracnose incidence did not show any significant difference. The pre-harvest application of 1-MCP has significantly delayed the ripening of fruits, but had no effect in delaying the spread of postharvest diseases. The result of this study once again proved that 1-MCP is an ethylene action inhibitor since it delays expression of its ripening attributes but could not inhibit or delay postharvest diseases of Cavendish fruits.

Normally, at the postharvest stage, bananas are prone to postharvest diseases such as crown rot/mold and anthracnose (Lassois et al, 2008; Duan, Joyce, and Jiang, 2007). 1-MCP could delay shelf life of bananas, but could not control the development of postharvest diseases.

Summary and Recommendations

Pre-harvest methods of 1-Methylcyclopropene (1-MCP) application have significant effects in delaying the ripening of Cavendish fruits, prolonging shelf life, and maintaining postharvest quality. However, while 1-MCP effectively delayed the ripening attributes, indicators of postharvest diseases, such as crown discoloration, crown rot/mold, and anthracnose failed to show any significant difference among treatments.

As for the best pre-harvest method of 1-MCP application, Stalk End Immersion (SEI) and Combination (SEI-BS) methods showed promising results in delaying its shelf life for up to 19 days before deterioration in ambient storage conditions, with SEI being the more cost-efficient between the two.

In order to prolong shelf life and preserve fruit freshness during transport, it is recommended to conduct more research to include the following: combining pre- and post-harvest 1-MCP application methods, storing the fruits at lower temperature, and pairing 1-MCP treatment with disease control.

Experimental research on the application of 1-MCP coupled with appropriate control on postharvest diseases, specifically on the use of beneficial microorganisms antagonistic to the disease-causing pathogens, is highly recommended.

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