International Journal of Agriculture Innovations and Research
Volume 8, Issue 1, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy):
Received: 22/06/2019 | Accepted on: 15/07/2019 | Published: 29/07/2019

Effect of 1-Methylcyclopropene (1-MCP) Postharvest Application on Quality of 'Lakatan' Banana Fruit

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Abstract – **Maintaining the postharvest quality of fresh bananas is a major trading challenge of the industry. 1-Methylcyclopropene (1-MCP) can prolong the postharvest quality of banana fruit by delaying the expression of ripening attributes and senescence through overtaking the binding of ethylene to its receptors thereby inhibiting ethylene signal transduction and downstream action. However, method of application could affect normal ripening and consequently the development of the quality components of banana fruit. In this study, the best method of 1-MCP application (gas exposure and spraying) was determined through observation of postharvest quality of 'Lakatan' banana fruits such as peel yellowing, sensory firmness, visual quality, weight loss, and disease incidence. 1-MCP application through gas exposure for 20 hours at 400 nL L^{-1} under room temperature significantly retard ripening as evident by delayed fruit yellowing and maintained firmness of banana fruit compared to spraying method. Moreover, weight loss of 1-MCP treated fruits (gas exposure and spraying method) was slower than control as evident on day 4 of storage onwards. Good visual quality of fruits treated with 1-MCP through gas exposure was maintained for 16 days of storage in comparison to spraying method and control for 10 days only. However, disease incidence of the fruits among all 1-MCP treatment methods and control was comparable under similar storage condition and 1-MCP concentration.**

Keywords – **'Lakatan' Banana, Postharvest Quality, Physiological Characteristics, Ethylene Action Blocker, Delaying Ripening.**

I. Introduction

Banana *(Musa spp.)* is a crop of vital importance to the food security of hundreds of millions of people. This tropical fruit is being grown in more than 120 countries with a total world production of 102 million metric tons in 2012 [1]. In the Philippines, bananas are grown abundantly and in fact the number one fruit crop in terms of production and hectarage. The country have exportable bananas, plantains and cooking type where 'Cavendish' is grown for export, 'Lakatan' as the most preferred dessert variety, and 'Saba'/'Cardaba' for chip-making and staple food.

The Philippines is among the world's leading exporter of bananas in the world. On a regional basis, Davao Region registered as the top producer of banana in the country. Among the varieties cultivated, 'Cavendish', the export variety accounts 48% followed by 'Lakatan' (30%), 'Saba' (11%) and others (11%) [2]. Although 'Cavendish' is extensively grown for export, 'Lakatan' is becoming popular due to its potential both in the local and international markets. The demand is also expected to heighten with the possibility for the 'Lakatan' bananas to be exported due to the shift of consumer preference from 'Cavendish'. Foreign buyers favour banana that is organically grown for a healthy lifestyle and a flavourful type of banana. In the current market scenario, 'Lakatan' bananas have consistent demand since it is considered as part of the healthy diet, but this level of demand in not perfectly satisfied due to limited farmers engaged in 'Lakatan' production [3]. Moreover, 'Lakatan' variety is favoured by the taste buds of Filipinos and a favorite dessert after meals. Its firmness and flavor are very delectable. Like any other banana, 'Lakatan' is highly perishable and its shelf life varies upon the age of maturity during harvest. When harvested on its full maturity, it could last up to 16 days at room temperature after ripening and can maintain its best quality [4].

'Lakatan' (*Musa acuminata AA Group*), a climacteric perennial fruit, is grown and harvested year-round which are generally harvested in a mature green state. Like any other type of banana, this fruit is known for its high perishability, short shelf-life and vulnerability to severe postharvest losses [5]. These type of high value commodities are traded internationally through cold container vessels while local markets were distributed using wooden crates cushioned with foams and/or banana bracts. During shipment, major losses often occur especially on the transport of fresh bananas to markets. These conditions negatively impact the market value of bananas which contributes banana quality depreciation and limits export trade [6]. The main causes of commodity deterioration are increased respiration rate, production of hormone such as ethylene, diseases caused by pathogens, physiological disorders, overall senescence and changes in composition and morphology. However, the excess of ethylene (plant growth hormone) production and pathological breakdown are the main responsible for higher postharvest decay, especially for climacteric fruits [7].

The use of modified atmosphere packaging, low temperature storage, control of postharvest diseases through synthetic fungicide and application of potassium permanganate-based ethylene scrubber applied around the unripe fruit [8] are the current practices of the major exporting countries including the Philippines. Yet, these strategies have limitations and inconsistency. Moreover, synthetic fungicides applied on fresh fruits and vegetables to preserve its freshness as well as its impact on the natural environment has created legal and consumer concerns [9].

Preventing the accumulation of ethylene around produce is among the approaches used to delay ripening of bananas. In recent years, researchers discovered effective compounds that control ethylene biosynthesis by Aminoethoxyvinylglycine (AVG) or block production, action, and 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 receptor level [10]. This gaseous plant growth and ripening regulator blocks the action and binding sites of ethylene by means of blocking the ethylene receptors in the tissues of plants, flowers, fruit and vegetables, thus preventing the ripening process [11].

The ability of 1-Methylcyclopropene (1-MCP) to delay ripening of mature-green 'Cavendish' bananas has been evaluated extensively over the years, yet, no study has been conducted for 'Lakatan'. Diverse results influence the effectiveness of 1-MCP which governed by various factors. These factors include variety of the crop, fruit maturity, levels of concentration, time of exposure, preharvest treatments, postharvest handling, storage conditions (temperature and humidity), and length of storage. The interactions of these factors affect the occurrence of physiological disorders of crops [12].

In this study, it was hypothesized that 1-Methylcyclopropene (1-MCP) can prolong the postharvest quality of 'Lakatan' banana fruits in terms of peel yellowing, sensory firmness, visual quality, weight loss, and disease incidence. Different methods of 1-MCP application were tested to determine its influence on the aforementioned quality parameters.

II. Materials and Methods

A. *Site and Duration of the Study*

The study was conducted at NEH Learning and Exchange Farm, Pantaron, Sto. Tomas, Davao del Norte last March - April 2018. The experiment was conducted and performed under ordinary room condition, an elevated kiosk that has open sides allowing the air to pass through.

B. *Experimental Design and Treatment*

The experiment was carried out following a Completely Randomized Design (CRD). There were three treatments which were replicated three times. The treatments were as follows: T1 - 1-MCP Gas Exposure (exposed for 20 hours; dosage: 400 nL/L^{-1} 1-MCP); T2 – 1-MCP Spraying (dosage: 400 nL/L^{-1} 1-MCP) and T3 – No 1-MCP application.

C. *Fruit Selection and Postharvest Treatment*

'Lakatan' fruits were harvested at the banana farm of USEP Tagum-Mabini Campus, Apokon, Tagum City. One week before the schedule of harvest, tagging in the field was done to ensure conformance to the quality attributes such as fruit age of 10 hanging weeks at harvest, uniform calibration of hands positioned on the 2nd - 4th from the distal hand, has 3 functional leaves at harvest, has uniform hand class of seven (7) per bunch and possessed a class A quality standard based on export market requirements. After harvesting the selected fruits, bunches were dehanded, weighed, labelled and transported to the research site. The fruit hands were then clustered carefully and the crown of the clusters were trimmed off smoothly, washed thoroughly and were disinfected with 10% sodium hypochlorite solution. Fruit clusters and fingers were submerged in the water for 15 minutes allowing the latex to coagulate. Fruits were then removed from the water and allowed to set aside for 5 minutes in the plastic crates in preparation for fruit treatment.

D. *1-MCP Fruit Treatment*

1-MCP Gas Exposure Method. A computed amount of 1-MCP powder (dosage: 400 nL/L^{-1} 1-MCP) was placed in a 150 ml glass container positioned inside the airtight chamber where the fruits were arranged. A tube was installed connecting to the glass container inside the chamber to the outside. After closing and sealing the chamber, a 10 ml distilled water was added through the tube. The water triggered the release of 1-MCP and eventually initialized instantaneously occupying the whole space of the chamber. The small fan inside the chamber was turned on and the chamber was kept closed for 20 hours. 1-MCP produced under Rohm and Haas (active ingredient: 1-Methylcyclopropene - 3.8%) was obtained from the University of the Philippines Mindanao Campus, Mintal, Davao City.

1-MCP Solution Spray Method. An aqueous spray solution was made by adding the 1-MCP powder in one liter distilled water. The prepared 1-MCP spray was applied to the fruits within 10 minutes right after its preparation. After spraying, the fruits were enclosed in plastic bags for 2 hours to allow time for binding of 1-MCP. After 2 hours, treated fruits were removed from the plastic bags, packed in a carton with treatment codes and placed on its respective storage areas.

E. *Storage Condition*

Ambient storage was done under ordinary room condition (26 - 28°C).

F. *Data Gathered*

Treated fruits were monitored and evaluated based on the quality parameters such as peel color change, fruit firmness, weight loss, visual quality and disease incidence. The peel color change was assessed visually on a daily basis by comparing the color of the peel to standardized banana color charts depicting the seven ripening stages of bananas [13]. This was determined by visual inspection using rating scale where 1 = Green; 2 = Light green, breaking towards yellow; 3 = Yellowish green, more green than yellow; 4 = Greenish yellow, more yellow than green; 5 = Yellow with green tips; 6 = All yellow; and 7 = Yellow, flecked with brown.

On the other hand, firmness of unpeeled fruits was obtained quantitatively using a hand-held penetrometer. The firmness or resistance to deformation was measured by pressing the penetrometer plunger perpendicular against the sample enough to sink the whole pointed part of the plunger. Firmness was gathered daily and the data were converted in Newton (N). The weight of each clusters was measured using a digital weighing scale. Accumulated weight loss was obtained by dividing the daily weight measurement to the initial weight measured before treatment or at Day 0, multiplied by 100. The visual quality was monitored using the visual quality rating (VQR) scale below following a 9-point Likert scale where 9,8 = Excellent Clean Skin (No defect); 7,6 = Good (Minor defects); 5,4 = Fair (Moderate defects); 3 = Poor, Limit of Marketability (defects serious); 2 = Limit of Edibility; and 1 = Non-edible under usual condition. In terms of disease incidence, fruits were inspected for incidence of postharvest diseases through recording the actual incidence of crown rot/ mold, cown discoloration and anthracnose.

G. *Statistical Analysis*

The data were analysed using the Analysis of Variance (ANOVA). Square root transformation was necessarily used on some parameters that signifies departure from normality making ANOVA invalid. Difference among the treatment means was compared using Tukey's Honest Significant Difference (HSD) test.

III. Results and Discussion

A. *Peel Color Changes*

Color change of the peel is an important indicator of ripeness of bananas. The peel color change of 'Lakatan' fruits under ambient storage condition as affected by method of 1-MCP application is shown in Table 1. Results revealed that the method of 1-MCP application significantly influence the peel color change of 'Lakatan' fruits. Fruits treated with 1-MCP through Gas exposure and Spraying method significantly delayed peel color change of 'Lakatan' fruits compared to untreated as evident from day 4 of storage up to day 10 (Figure 1). However, as observed on day 13, 1-MCP gas exposure maintained its green peel color while 1-MCP spraying method manifests yellowing. From this period onwards, untreated fruits significantly continued to turn yellow which was way ahead of Gas exposure and Spraying methods.

The results corroborate with the numerous research findings that 1-MCP delays peel color change in bananas. The delay in the change of peel color of 'Lakatan' fruits was similar to the studies on 'Cavendish' bananas conducted by several authors [14]. Moreover, Gas exposure method was found to be an effective means of 1-MCP treatment for banana relative to the result of Trivedi in 2012.

The ambient storage condition also interplayed the change of peel color of the fruit as temperature and relative humidity (RH) played an important role in the peel color change of 'Lakatan' fruits. Those fruits without 1-MCP treatment changed its color sharply, given the storage temperature range of 26 – 29 °C and RH of 78 – 86 % which were conducive for physiological and chemical activity of most climacteric fruits including bananas.

The peel of unripe bananas is green in color due to its chlorophyll content. Bananas require the green pigment as an efficient way of supplying nutrients mainly starch to the pulp. The fruit is firm when all that starch has been stored in the fruit. The chlorophyll in the peel breaks down and the starch within the fruit is converted into simple sugars. As a result, the peel turns yellow and the fruit softens up and becomes sweet. Yellowing accelerates with a significant increase of temperature and relative humidity of the storage.

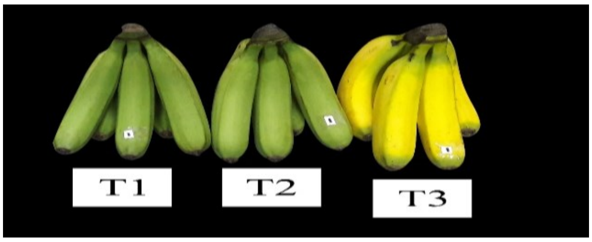

Fig. 1. Peel color change of 'Lakatan' banana fruits at day 10 of storage as influenced by methods of 1-MCP application through Gas Exposure (T1), Spraying (T2) and Control (T3; No 1-MCP).

Wide range of crop species from fruits, vegetables and other horticultural crops react with 1-MCP treatment which could either prevent or delay change its peel color. In non-climacteric fruits, degreening of oranges *(Citrus sinensis)* was completely blocked by 1-MCP and can be stimulated by exogenous ethylene. For climacteric fruits, 1-MCP delayed skin color change in avocado [17]. Moreover, the response varies based on the cultivar and maturity of crops being treated, temperature and relative humidity during treatment and storage, concentration of 1-MCP and manner of treatment [12]. The presence of endogenous and exogenous sources of ethylene also plays vital role along the process.

In this experiment, 'Lakatan' fruits treated with 1-MCP became yellow before they softened which is comparable with the research outcomes of sisler et al. (2001) on his 'Cavendish' experiments. When 'Lakatan' fruits were treated with 1-MCP and subsequently treated with ethylene, degreening was delayed but fruit manifest patchy and uneven peel color similar to 'Cavendish' bananas [19]. Harris et al. (2000) also found that 'Cavendish' bananas treated with 1-MCP did not have commercially acceptable color development. In the case of 'Lakatan' fruits, however, at certain time following patchy and uneven color visibility, 'Lakatan' fruits recover and eventually develop uniform yellowing of the peel.

B. *Fruit Firmness*

Fruit softening of bananas correlates with the changes in the chemical components of the fruit as it ripens. Table 2 shows the fruit firmness (expressed in Newton - N) of 'Lakatan' fruits as affected by methods of 1-MCP application under ambient storage condition. Statistical analysis revealed that methods of 1-MCP application significantly influenced ripening process as evident in the softening of the fruit. Fruits applied with 1-MCP through gas exposure have firmer pulp than fruits treated with 1-MCP through spraying as well as untreated fruits as evident on day 4 of storage onwards.

Softening was significantly affected with the storage temperature and concentration of relative humidity. As 1-MCP treated fruits delayed its peel color change under ambient condition, softening was likewise delayed as evident by firmer pulp than fruits without 1-MCP treatment. Green peel was held until 13 days of storage, in concurrence with the delay of fruit softening. These conditions favor international trade such as in China, Japan and Korea especially on cases of SGRT (Soft Green Ripened Tolerance), a condition where banana appears green but has soft pulp.

As mentioned earlier, the softening of bananas is 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 viscosity of the pulp of bananas are major physical components of pulp softening. Results of his chemical analysis evidently 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 whereby decrease in the contents of pectic and hemicellulosic polysaccharides and starch is the main cause for the pulp softening process [20].

While 1-MCP delayed softening of bananas, other crop species were not affected. 1-MCP delayed softening in avocado by 4.4 days, custard apple (Annona) by 3.4 days, and mango by 5.1 days. Moreoevr, Papaya (Carica papaya) softening was delayed by 15.6 days with 1-MCP treatment [21]. Apple tissue mechanical properties were found to change less in 1-MCP-treated fruit than in untreated fruit [22].

More detailed examinations of fruit softening showed that polygalacturonase (PG) and cellulose activities were lowered by 1-MCP, however, activities of both enzymes were still present and avocado fruit ripened and softened normally [23]. Jeong et al. (2002) found that PG activity was completely suppressed for up to 10 days, indicating that softening can occur without PG activity in avocado. Pectinmethylesterase activity was delayed in 1-MCP-treated fruit compared with the control but followed a similar pattern. Uronic acid content in avocado decreased in the control but the 1- MCP-treated fruit showed little change [17].

C. *Accumulated Weight Loss*

At the time of harvest the water content of bananas is very high and produce has a fresh appearance and crisp texture. Harvesting removes the plant part from its water supply and the product begins to lose weight. Therefore, weight loss of bananas is a consequence of loss in water or transpiration. Shown in table 3 are the accumulated weight loss expressed in percentage of 'Lakatan' fruits as affected by method of 1-MCP application under ambient storage condition. Results showed that fruit weight was significantly affected by method of 1-MCP application. Degree of weight loss on banana fruits without 1-MCP application was higher than 1-MCP treated fruits as evident on day 4 of storage onwards. Among 1-MCP treated fruits, fruits treated through gas exposure registered the lowest degree of weight loss than spraying method of application.

With this evidence, 1-MCP treated bananas decelerated its water loss as the fruit delays the ripening process, thereby reducing the degree of weight loss. Furthermore, weight loss of fruits was associated with loss of water due to transpiration and has direct relationship on the temperature and relative humidity at storage. The storage environment of this experiment was conducive to rapid water loss from harvested fruits and has been shown to accelerate ripening. Water loss causes fruits to loss its weight and firmness and the peel becomes soft and shrivelled [24].

D. *Visual Quality*

Visual Quality of fruits is an important market requirement of bananas as it limits marketability and influence customer preference. In this study, visual quality of 'Lakatan' fruits decreased significantly as shown in table 4. Fruits applied with 1-MCP through Gas exposure and spraying significantly maintained better visual quality than untreated fruits as evident on day 4 up to day 7 of storage. However, visual quality of these fruits declined as evident in day 19 of storage which was exceeded by 1-MCP untreated fruits.

The results inferred that as the storage days under ambient condition continued to progress, 1-MCP treated fruits prolonged its shelf life but slowly lose its visual quality over time. Perhaps, untreated fruits ripen earlier and were already consumed while 1-MCP treated fruits tend to prolong shelf life allowing postharvest diseases affecting the fruits. Additionally, during longer period of storage at ambient condition, the peel becomes soft and shrivelled [24].

In addition, as 1-MCP treated fruits delayed ripening, water loss was also reduced. Reducing water loss improves produce appearance, quality and shelf life [25], which correlates with the results of this experiment where fruits treated with 1-MCP showed better visual quality during the earlier days of storage. However, as the fruits eventually ripen, it continuously lost its water content which causes wilting and/ or shriveling of the fruit as manifested by poor visual quality compared to fruits with no 1-MCP application.

While 1-MCP loses its visual quality over time under ambient storage, this can probably be improved through storage at lower temperature to inhibit growth of postharvest pathogens. In some cases, visual quality of 1-MCP treated fruits is associated with higher incidences of external blemishes in papaya and custard apple [21]. Wooliness and reddening of nectarines was more prominent in 1-MCP-treated fruit as compared with untreated controls. In addition, no reported quality problems in apricots when treated with 1-MCP [26]. Likewise, plum quality was not adversely affected by 1-MCP treatment [27].

E. *Disease Incidence*

Postharvest diseases are economically important as this affects various quality considerations. In this study, the development of crown rot, crown discoloration and anthracnose incidence were evaluated. Statistical analysis failed to show any significant difference to all treatments.

Fig. 2. 'Lakatan' Banana fruits either treated or untreated with 1-MCP infected with Crown rot/mold at day 3 of ambient room storage.

Crowns of all fruits either treated or untreated with 1-MCP have already infected with the same level of crown rot infection on the following storage days onwards (Figure 2). Similarly, 'Latakan' fruits did not favored the development of crown discoloration though out its storage days under ambient condition. In terms of anthracnose incidence, the methods of 1-MCP application and ripening system of 'Latakan' fruits did not favored anthracnose development.

The result of this study elucidates the effect of 1-MCP as an ethylene action inhibitor and could not inhibit nor delay postharvest diseases of 'Lakatan' fruits. Normally, at the postharvest stage of bananas, the perishable fruits are prone to postharvest diseases such as crown rot/molds and anthracnose [6]. The effect of 1-MCP on various disorders and diseases is commodity specific and varies depending on species. In some cases, 1-MCP treatment alleviates disorders. It was also found an increase in disease with high 1-MCP concentrations on strawberries [28]. 1-MCP may inhibit a beneficial metabolic response or stimulate an undesirable characteristic, possibly relating to a natural defense mechanism [29].

IV. Conclusion

1-Methylcyclopropene (1-MCP) has significant effects in delaying the ripening of 'Lakatan' fruits in terms of prolonging shelf life and maintaining postharvest quality. In this study, 1-MCP treated fruits delayed its shelf life and slowed down subsequent deterioration at ambient storage condition. As to the best method of 1-MCP application, Gas exposure method showed promising result in maintaining postharvest quality of 'Lakatan' banana fruits in terms of peel yellowing, fruit firmness, accumulated weight loss, visual quality and disease incidence. Fruits treated with 1-MCP through gas exposure significantly retarded its peel color change, have firmer pulp, have lowest degree of weight loss and maintained better visual quality among treatments. On the other hand, the development of crown rot, crown discoloration and anthracnose incidence failed to show any significant difference. The result of this study elucidates the effect of 1-MCP as an ethylene action inhibitor and could not inhibit nor delay postharvest diseases of 'Lakatan' fruits. Moreover, while 1-MCP loses its visual quality over time under ambient storage, this can probably be improved through storage at lower temperature to inhibit growth of postharvest pathogens.

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Table 1. Peel color change of 'Lakatan' fruits as influenced by method of 1-MCP application [1].

Method of 1-MCP Application	Days of Storage								
	Day 1 ns	Day 4 **	Day 7 **	Day 10 **	Day 13 **	Day 16 **	Day 19 **	Day 22 **	Day 25 ns
Gas Exposure	1.00	1.00 a	1.00 a	1.06 a	1.92 a	3.31 a	4.97 a	5.69 a	7.00
Spraying method	1.00	1.00 a	1.06 a	1.31 a	2.78 b	4.14 b	5.28 b	7.00 b	7.00
Control (No 1-MCP)	1.00	2.64 b	4.42 b	4.89 b	5.28 c	5.97 c	7.00 c	7.00 c	7.00
CV		24.8%	35.62%	33.41%	30.51%	38.50%	31.95%	15.35%	

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

Table 2. Fruit firmness of 'Lakatan' fruits as influenced by method of 1-MCP application [1].

Method of 1-MCP Application	Days of Storage								
	Day 1 ns	Day 4 **	Day 7 **	Day 10 **	Day 13 **	Day 16 **	Day 19 **	Day 22 **	Day 25 **
Gas Exposure	44.02	42.69 a	40.88 a	36.07 a	29.56 a	21.35 a	13.28 a	2.90 a	1.98 a
Spraying method	44.41	41.35 b	39.83 b	34.91 b	26.20 b	15.06 b	8.58 b	2.09 b	1.86 b
Control (No 1-MCP)	44.54	23.67 c	19.09 c	18.33 c	12.24 c	5.10 c	1.52 c	1.49 c	1.52 c
CV		2.40%	9.74%	47.12%	43.25%	30.71%	21.97%	16.64%	15.94%

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

Table 3. Accumulated Weight loss of 'Lakatan' fruits as influenced by method of 1-MCP application [1].

Method of 1-MCP Application	Days of Storage								
	Day 1 ns	Day 4 **	Day 7 **	Day 10 **	Day 13 **	Day 16 **	Day 19 **	Day 22 **	Day 25 **
Gas Exposure	0	1.92 a	5.02 a	7.15 a	9.10 a	11.34 a	13.14 a	14.28 a	14.69 a
Spraying method	0	2.70 b	5.81 b	7.77 b	9.82 b	13.03 b	13.67 b	15.82 b	15.82 b
Control (No 1-MCP)	0	6.57 c	13.21 c	14.51 c	15.24 c	16.23 c	18.83 c	18.83 c	18.83 c
CV		2.40%	9.74%	47.12%	43.25%	30.71%	21.97%	16.64%	15.94%

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

Table 4. Visual quality of 'Lakatan' fruits as influenced by method of 1-MCP application [1].

Method of 1-MCP Application	Days of Storage								
	Day 1 ns	Day 4 **	Day 7 **	Day 10 **	Day 13 **	Day 16 **	Day 19 **	Day 22 **	Day 25 **
Gas Exposure	8.64	7.92 a	7.25 a	6.86 a	6.42 a	6.06 a	5.22 a	4.83 b	4.25 b
Spraying method	8.47	7.81 a	7.11 a	6.33 b	5.81 b	5.25 c	4.56 b	4.28 b	4.28 b
Control (No 1-MCP)	8.56	7.50 b	6.56 b	6.03 b	5.83 c	5.64 b	5.14 a	5.14 a	5.14 a
CV		6.46%	9.29%	13.93%	14.36%	16.29%	20.29%	21.94%	24.63%

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