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1-MCP Microbubbles Influence in Fruit Color and Quality of Dragon Fruit

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Abstract

The most important market characteristic of dragon fruit (*Hylocereus undatus*) is an intense and uniform peel color and green fruit bracts. Any alteration on the peel or bracts color will affect the shelf life and marketability of the fruit. 1-methylcyclopropene (1-MCP), an ethylene antagonism, is widely used to retain quality and extend commercial life of fresh produces. However, the application of 1-MCP in liquid form is still limited, this this research aimed to study the supply of 1-MCP using microbubbles technology (1-MCP-MBs) on external characteristics of dragon fruit. Dragon fruit was dipped for 10 minutes in1500 ppb 1-MCP-MBs and then stored at 13 °C during 20 days. A control treatment was dipped into tap water for 10 minutes. Measures were taken every 4 days, and the results found that1500 ppb 1-MCP-MBs treatment was effective in maintain greener bracts, as expressed by the significant higher hue values by day 20th of storage, when compared to the control. Also a better retard in L* value changes was achieved when the fruit was treated with 1-MCP-MBs, maintaining similar figures during the 20 days of storage. However, weight loss was not influenced by any of the two treatments, Results support MBs technology viability, as an alternative to traditional applications of 1-MCP. Reducing exposure times, thus allowing a faster connection within the supply chain stages.

Keywords: Dragon fruit, 1-MCP-MBs, color changes

Introduction

Pitaya, Pitahaya or Dragon fruit is an exotic non-climacteric fruit indigenous to Central and South America, which is largely cultivated in a wide range of countries including Mexico, Colombia, USA, Israel, Vietnam, Philippines and Thailand, reaching its best eating quality when harvested ripe (Freitas and Mitcham, 2013; Obenland *et al*., 2016). Among species of dragon fruit, notable differences can be made based on the peel and flesh color. The white-pulp (*Hylocereus undatus*) and red pulp dragon fruit (*Hylocereus polyrhizus*) have become important crops in local markets due to the sweet flesh, containing numerous tiny black seeds, aroma and nutritional value, being a source of dietary fiber, calcium, magnesium and essential fatty acids, present in the seeds composition (Kammapana, 2014). Color is the most important characteristic in dragon fruit, bracts with an intense and uniform green color are desired, any alteration on the peel or bracts color will affect the shelf life and marketability of the fruit.

1-methylcyclopropene is widely used to retain quality and extend commercial life on climacteric fruits, however positive results has been obtained when treating some non-climacteric fruits as dragon fruit, inhibiting degreening and color changes, though its application has minor effects on internal fruit-quality parameters (Li *et al*., 2016).1-MCP is usually delivered as a gas in sealed environments to prevent the1-MCP gas from being released and long time to use around 6-24 h depending on the commodity. In the case of bananas, the periods of fumigation are between 12 and 24 h at concentrations ranging from 5 to 1000 nL.L^{-1} and higher (Pongprasert and Srilaong, 2014). However, this fumigation technique may not be practical on a commercial scale because of high investment costs for airtight systems and other facilities. Recently, preparations of 1-MCP designed for use as aqueous solutions have been formulated, facilitating broader agricultural applications for this ethylene-action inhibitor. However, the results of ripening at attenuation have not always been beneficial because of the limitations

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of solubility of 1-MCP in water at standard pressure. One of the most significant characteristics of MBs is they shrink in water and ultimately collapse if they reside in water for a long time; in contrast, ordinary macrobubbles quickly rise and burst at the surface of water. Thus, this research will mainly study the use of 1-MCP gas dissolved in microbubble (1-MCP-MBs) on delaying changes of color in dragon fruit peel.

Materials and Methods

Dragon fruit at commercial maturity stage was obtained from a GAP certified farm located in Rangsit, Pathumthani province on December 2016. Fruits on the range of 300 – 350 g were delivered at King Mongkut's University of Technology Thonburi, Postharvest Technology Program facilities. The experimental set up consisted in a Complete Randomized Design (CRD) arrangement with 2 factors: treatment and storage days (time). The treatment factor had 2 levels: control treatment and 1500 ppb 1-MCP-MBs. Samples were analyzed before storage and every four days until day 20 of storage (6 measure points). Dragon fruit dipped into fresh water for 10 minutes was set as the control treatment and those dipped into a 1500 ppb 1-MCP-MBs concentration. After dried at ambient condition, the fruits were moved into a storage room at 13 °C.

Ethylene production and respiration rate where measured by gas chromatography technique while for tracking the color changes in the bracts, a Minolta CR-400 colorimeter was used. Additional analysis of TSS by digital refractometer and texture were carried out, the latter was measured by a puncture test into the flesh after cutting in halves of each dragon fruit. Mean comparisons among treatments and storage times were determined using Tukey's test at the 0.05 level of significance.

Results

Ethylene production and respiration rate were analyzed with no interaction between factors (treatment× time), instead means comparison were defined by the treatment main effect for each day of storage. Ethylene figures for day 4 reported a significant increment in production for the control treatment. For the respiration rate at day 16 the control treatment reported a significant peak when compared to the 1500 ppb 1-MCP-MBs treatment.

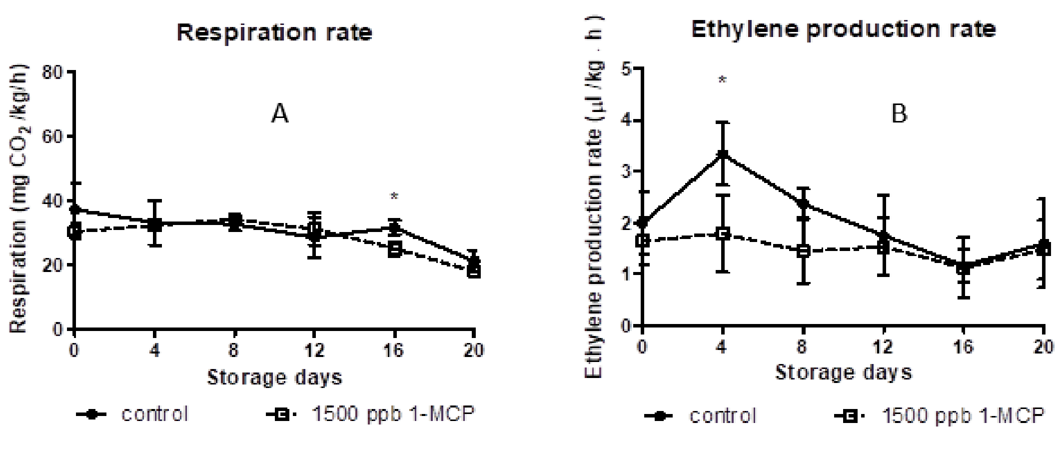

Figure 1 Respiration (A) and ethylene production (B) rates of dragon fruit during a 20 days of storage period at 13 °C. (*) indicates statistically significant difference between means (means ± standard deviation) at each evaluation time (Tukey's test, p = 0.05).

As for the internal quality of dragon fruit, texture and TSS experiments were done. Since the statistical analysis reported interaction between factors (treatment × time), it allows to compare how figures changed among days and treatments. In texture for the control treatment, reported values did not show significant differences until day 12 of storage. In contrast the 1500 ppb 1-MCP-MBs treatment could maintain initial figures until day 16 of storage. For Total Soluble Solids, we observe a similar trend in the figures for day 4 in both treatments, showing a significant increase but a second peak at day 16 exclusive for the control treatment. The rest of days TSS were kept as the initial reported figures.

Table 1 Texture means comparison. Interaction of factors effect (treatment × time)

Texture (N) (Mean ± SD)						
Treatment	Day 0	Day 4	Day 8	Day 12	Day 16	Day 20
Control	3.16 ± 1.05a	3.49 ± 0.38a	2.76 ± 0.71abc	2.63 ± 0.43abc	2.08 ± 0.59bc	2.11 ± 0.24bc
1500 ppb 1-MCP-MBs	3.36 ± 0.73a	3.16 ± 0.31a	2.88 ± 0.46abc	2.69 ± 0.29abc	2.65 ± 0.16abc	1.99 ± 0.33c

Different letters indicate the statistically significant difference (Tukey's test, p = 0.05) Minimum significance difference 0.9263

Table 2 TSS means comparison. Interaction of factors effect (treatment × time)

Total Soluble Solids (° Brix) (Mean ± SD)						
Treatment	Day 0	Day 4	Day 8	Day 12	Day 16	Day 20
Control	13.28 ± 0.09g	18.45 ± 0.37a	14.15 ± 1.13fg	14.00 ± 0.48fg	16.38 ± 0.45bcde	14.45 ± 0.85efg
1500 ppb 1-MCP-MBs	14.43 ± 0.22efg	17.68 ± 0.77ab	14.58 ± 0.51defg	15.50 ± 0.38cdef	14.48 ± 1.94efg	15.35 ± 0.63cdef

Different letters indicate the statistically significant difference (Tukey's test, p = 0.05) Minimum significance difference 2.0265

Table 3 L* value and Hue angle means comparison. Interaction of factors (treatment × time)

L* value and Hue angle (Mean ± SD)						
Treatment / L* value	Day 0	Day 4	Day 8	Day 12	Day 16	Day 20
Control	54.06 ± 1.96e	55.27 ± 2.24de	56.36 ± 2.63cde	61.17 ± 2.71a	61.05 ± 3.83a	61.99 ± 2.88a
1500 ppb 1-MCP-MBs	53.85 ± 2.58e	54.25 ± 2.34e	55.19 ± 1.84de	57.13 ± 2.74bcde	56.47 ± 2.39bcde	55.51 ± 2.45cde
Hue angle						
Control	111.28 ± 8.30a	111.14 ± 5.83a	109.53 ± 3.84abc	101.70 ± 5.29cdefg	97.14 ± 8.01gh	88.16 ± 10.74i
1500 ppb 1-MCP-MBs	113.67 ± 2.71a	111.99 ± 3.19a	108.19 ± 3.92abcd	102.03 ± 4.91bcdefg	100.55 ± 5.21defg	100.10 ± 4.60efg

Different letters indicate the statistically significant difference (Tukey's test, p = 0.05) Minimum significance difference 3.1737 for L* value and 6.6026 for Hue angle.

As an interaction effect of factors *(*treatment × time*)* was statistically determined, is possible to compare changes in values all along the storage time. For L* value, the control treatment presents similar values until day 8 of storage, from then on statistically differences are reported; while the 1500 ppb 1-MCP-MBs treatment does not show significant differences since day 0 until last day of storage. Lastly the Hue angle stays unmoving in both treatments until day 8 of storage, thereafter goes down until at day 20 control treatment shows the lowest figure. At day 20, 1500 ppb 1-MCP-MBs treatment hue angle is higher than the control.

Discussion and Conclusions

Results of the experiments suggest that 1500 ppb 1-MCP-MBs application on dragon fruit, affects internal traits such texture and total soluble solids, as well as maintaining better color characteristics in the fruit bracts, during a 20-days long storage period at 13 °C when compared to untreated samples. Treatment figures for L* value were preserved during the storage and for the hue angle, significant lower values were reported at the last day proving its effectiveness in retain greener bracts. Regardless of being a non-climacteric fruit, treatment may have influenced its ethylene production during the first four days of storage and later, maintaining its respiration rate steady when the control treatment reported a significant increase at day 16.

Relevant research regarding temperature storage and different kinds of packaging can be found for dragon fruit (Freitas and Mitcham, 2013; Obenland *et al*., 2016) but for works involving 1-MCP utilization is nearly scarce. Deaquiz *et al*., 2014 found that yellow dragon fruit exposed to 600 mgL^{-1} reduced respiration rate and preserved firmness, going accord to our results where we used a 56x lower concentration. Another study from Li et al., 2016 found to delay bracts senescence in dragon fruit by a 24 hours exposure at 1 μLL^{-1} 1-MCP concentration which we achieved by a 10 minutes water dip at a similar concentration.

1-MCP Micro bubbles application brings a new alternative to preserve quality traits in commodities during their market life. Present long-exposure periods inconvenience for gaseous 1-MCP treatments turned into short-time water dips remarks the relevance of this technique. Further research should be done taking into consideration market demands specificities for dragon fruit, besides screening out time-concentration combinations for 1-MCP-MBs treatments.

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