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# ผลของการรม 1-MCP เพื่อรักษาคุณภาพของกล้วยน้ำว้าแบบแบ่งเป็นหวีย่อยสำหรับตลาดค้าปลีก
# Effect of 1-MCP Fumigation for Preserving the Quality of 'Namwa' Subcluster-Isolated Bananas for the Retail Markets

Yuni Kartika[1] ทันวลี ศรีนนท์[1,2] ณัฐชัย พงษ์ประเสริฐ[1,2] และผ่องเพ็ญ จิตอารีย์รัตน์[1,2,*]
Yuni Kartika[1], Thanwalee Srinon[1,2], Nutthachai Pongprasert[1,2] and Pongphen Jitareerat[1,2,*]

## Abstract

The work aimed to study the effect of 1-methylcyclopropene (1-MCP) on the quality of 'Namwa' bananas for retail markets. Banana hands were cut into small clusters with 3-4 fingers per cluster, then fumigated with 1-MCP at 0 (control), 250, and 500 ppb at 25°C for 6 hr. Afterward, all samples were kept at the ambient temperature (25°C), and the respiration rate, ethylene production, and fruit quality were determined at three days intervals for 9 days. Results found that treatment of 1-MCP at 250 and 500 ppb delayed ethylene production. In the control fruit, the highest respiration rate appeared on day 3, and the highest ethylene production was found on day 6, whereas the respiration rate and ethylene production of 1-MCP treatment increased slowly during storage, which led to delay in the ripening and senescence in compared to the control. 1-MCP treatment could retard the increase in total soluble solids (TSS), titratable acidity (TA), total sugar content, and maintain firmness. This result suggested that treatment of 1-MCP at 250 and 500 ppb has the potential to maintain the quality of subcluster-isolated bananas, which extends their shelf life for retail markets.

**Keywords:** bananas, ethylene inhibitor, respiration rate

## บทคัดย่อ

การศึกษาผลของการรม 1-Methylcyclopropene (1-MCP) เพื่อรักษาคุณภาพของกล้วยน้ำว้าแบบแบ่งเป็นหวีย่อยสำหรับตลาดค้าปลีก ทำโดยตัดกล้วยน้ำว้าเป็นหวีย่อย หวีละ 3-4 ผล และรมด้วย 1-MCP ที่ความเข้มข้น 0 (ชุดควบคุม), 250 และ 500 ppb ที่ 20 องศาเซลเซียส นาน 6 ชั่วโมง และนำไปเก็บที่ 25 องศาเซลเซียส ตรวจวิเคราะห์อัตราการหายใจ การผลิตเอทิลีน และคุณภาพของกล้วยทุก 3 วัน นาน 9 วัน ผลการทดลองพบว่า การรม 1-MCP ความเข้มข้น 250 และ 500 ppb มีผลชะลอการสร้างเอทิลีน กล้วยที่ไม่ได้รม (ชุดควบคุม) ปรากฏอัตราการหายใจสูงสุดในวันที่ 3 และอัตราการผลิตเอทิลีนสูงสุดในวันที่ 6 ในขณะที่อัตราการหายใจและการผลิตเอทิลีนของกล้วยที่รม 1-MCP เพิ่มขึ้นอย่างช้าๆระหว่างเก็บรักษา เป็นผลทำให้กล้วยที่รม 1-MCP เข้าสู่กระบวนการสุกและการชราภาพช้าเมื่อเทียบกับกล้วยชุดควบคุม การรม 1-MCP มีผลชะลอการเพิ่มขึ้นของปริมาณของแข็งที่ละลายน้ำได้ ปริมาณกรดที่ไทเทรตได้ ปริมาณน้ำตาลทั้งหมด และช่วยรักษาความแน่นเนื้อของกล้วยได้ดี ผลการทดลองนี้แสดงให้เห็นว่า 1-MCP ที่ 250 และ 500 ppb มีศักยภาพในการรักษาคุณภาพกล้วยน้ำว้าแบบแบ่งเป็นหวีย่อย ทำให้สามารถวางจำหน่ายในตลาดค้าปลีกได้นานขึ้น

**คำสำคัญ**: กล้วย สารยับยั้งเอทิลีน อัตราการหายใจ[1]

## Introduction

'Namwa' banana (*Musa paradisiaca*, ABB Group) contains a large number of fruits that the consumers cannot eat in a short period due to its faster ripening after buying. Therefore, selling bananas in a small cluster may meet the needs of consumers. However, banana is a typical climacteric fruit with a characteristic rise in ethylene production and respiration rate during ripening, and usually harvested green at about 75% maturity, transported to distant markets, and ripened afterward (Kader, 2002). The green life of bananas can be

[1] Division of Postharvest Technology, School of Bioresources and Technology, King Mongkut's University of Technology Thonburi, Bangkok 10140
[2] Postharvest Technology Innovation Center, Science, Research and Innovation Promotion and Utilization Division, Office of the Ministry of Higher Education, Science, Research and Innovation 10400

extended by using ripening retardants such as 1-MCP. 1-MCP acts as an ethylene antagonist; its function is to slow down the ripening process by binding ethylene to send ripening signals to receptors, 1-MCP acts as an efficient ethylene antagonist, and its effects can persist for a long time (Sisler and Blankenship, 1996) Thus, this study was carried out to evaluate the effect of 1-MCP fumigation for preserving the quality of 'Namwa' subcluster isolated bananas for the retail market.

## Materials and Methods

### Plant Materials and 1-MCP Fumigation

'Namwa' bananas at the commercial stage were washed with tap water followed by sodium hypochlorite (NaOCl) solution at 200 ppm for 5 min and air-dried at ambient temperature. A hand of banana was cut as a small cluster with 3-4 fingers per subcluster. Banana samples were divided into three groups and then fumigated with 1-MCP at concentrations of 0 (control), 250, and 500 ppb. The subclusters of banana were placed into the glass closed chamber with 43 L volume. The 10.25 mg and 21.5 mg of 1-MCP for 250 and 500 ppb, respectively were placed inside the chamber. The fumigation process was assisted by adding warm water to 1-MCP power and the samples were incubated for 6 hr at 25°C. Afterward, all samples were kept at 25°C for 9 days. Each treatment consisted of 3 small banana clusters (replications). Banana samples were randomly collected to investigate the qualities every 3 days interval for 9 days.

### Respiration rate, ethylene production, and fruit quality determination

Respiration rate and ethylene production were detected using the gas chromatograph apparatus (GC-8A, Shimadzu), and the results were reported as mg $CO_2$/kg.hr and μL$C_2H_4$/kg.hr, respectively. Firmness was measured using a Texture Analyzer (TA.XT plus stable micro-system, Surrey, UK), and the result is expressed as newton (N). Total soluble solid (TSS) and titratable acidity (TA) were measured by blending the fruit homogenously and centrifuging to obtain a clear juice, TSS determination using a digital refractometer expressed as a percentage. The TA determination was conducted by titrating the juice with 0.01 M NaOH until the color of the solution changed to pink (phenolphthalein indicator), and its value was expressed as percentages (%). Total sugar analysis was done by a phenol-sulfuric method as described by Dubois *et al*. (1956), and the result is reported as mg/100g.

All data were analyzed by analysis of variance using SAS. A completely randomized design and the least significant differences were used to evaluate significant differences between mean values ($P < 0.01$).

## Results and Discussion

This experiment showed that the respiration rate and ethylene production of bananas were suppressed by 1-MCP treatments (Fig.1A and 1B). The respiration rate of non-treated bananas reached the peak on the third day of storage, while 250 and 500 ppb 1-MCP treated bananas gradually increased from the initial day to 9$^{th}$ day and had not yet reached the peak (Fig. 1A). In a similar study reported by Jiang *et al*. (1999), 1-MCP treatment significantly delayed the peaks of respiration rate and ethylene production of bananas. 1-MCP treatments have successfully inhibited respiration and ethylene production in various fresh produce, including strawberries, apples, Cavendish bananas, pears, pineapples, avocados, and tomatoes (Blankenship and Dole, 2003). 1-MCP is thought to occupy ethylene receptors such that ethylene cannot bind and elicit action. The affinity of 1-MCP for the receptor is approximately 10 times greater than that of ethylene. Compared with ethylene, 1-MCP is active at much lower concentrations. 1-MCP also influences ethylene biosynthesis in some species through feedback inhibition (Sisler and Blankenship, 1996). Thus, low respiration and ethylene production of bananas may imply that 1-MCP prevents the formation of the ethylene receptor complex and blocks the ethylene-induced signaling pathway.

Bananas are highly susceptible to softening during ripening related to changes in cell wall components and starch degradation (Seymour *et al*., 1993). 1-MCP treatment significantly delayed the drop in flesh firmness of the banana (Fig. 2A) it may be due to the ability of 1-MCP to delay the production and action of ethylene. Jiang *et al*. (1999) reported that softening in bananas was retarded by 1-MCP. In banana flesh, starch degradation into soluble sugar may contribute to the rise of TSS and total sugar during the ripening process (Wills *et al*., 1984). Activities of enzymes during the ripening process cause starch degradation being sugar and resulted increase of TSS and total sugar content. Our result showed that TSS and total sugar progressively increased during the storage, but these increases were retarded by 1-MCP treatment (Fig. 2B and 2D). This may be because of 1-MCP treatment delay in ethylene production and, consequently, delay in fruit ripening (Fan *et al*., 1999). TA content increased to its peak and coincided with the rise of ethylene accumulation and started declining. 1-MCP treatment delayed the increases of TA in bananas during storage (Fig. 2C) due to a delay in the ethylene production of bananas (Seymour *et al*., 1993).

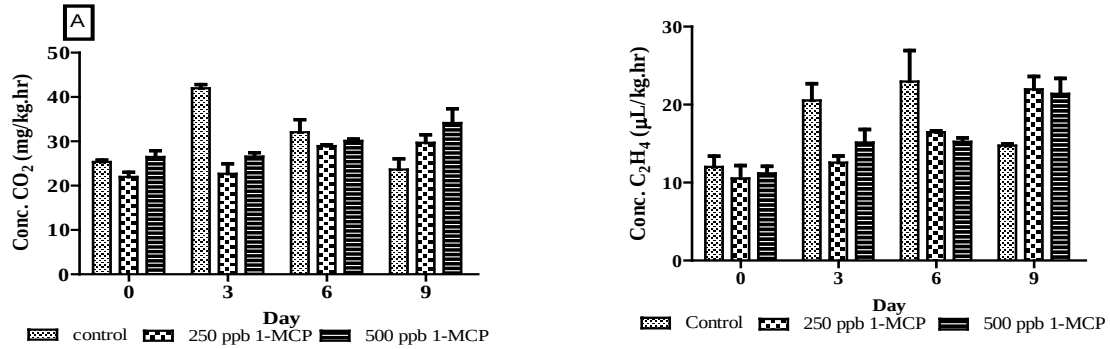


**Figure 1.** Effect of 1-MCP fumigation on the respiration rate (A) and ethylene production (B) of 'Namwa' bananas during storage at 25°C for 9 days.

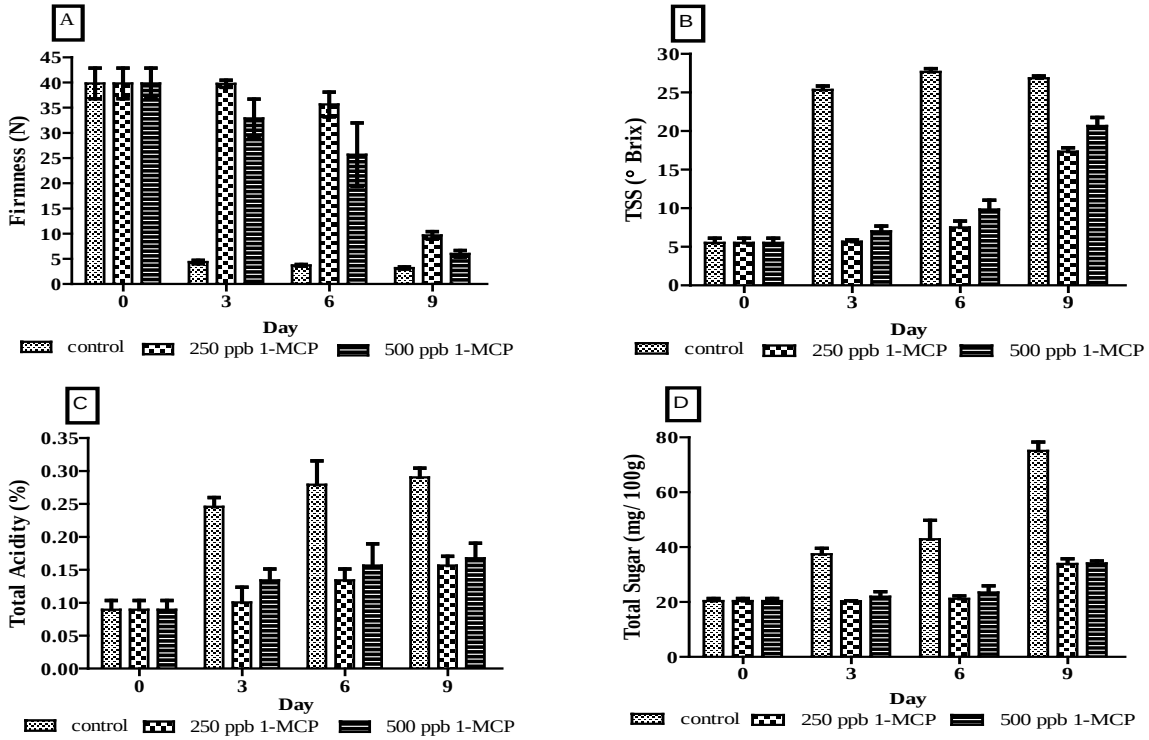


**Figure 2.** Effect of 1-MCP fumigation on the firmness (A), TSS (B), total acidity (C), and total sugar (D) of 'Namwa' bananas during storage at 25°C for 9 days.

## Conclusion

1-MCP fumigation at 250 and 500 ppb significantly maintained the quality of 'Namwa' bananas during storage at 25ºC as it acts as an effective anti-ethylene compound. 1-MCP treatment delayed the ethylene and respiration rate. In the control, the respiration rate reached the peak on day 3, and the ethylene production peak was found on day 6, whereas the respiration rate and ethylene production of 1-MCP treatment still increased slowly during storage for 9 days. 1-MCP treatment showed a significant delay in the banana ripening as indicated by low levels of TSS, TA, and total sugar content, and the fruit firmness was maintained.

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