

## Effect of 1-Methylcyclopropene on the Quality of 'Keitt' Mango Fruits

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### Summary

Experiment was conducted to determine how 1-methylcyclopropene (1-MCP) treatment affect quality characteristic of 'Keitt' mango fruits at room temperature ( $27\pm 2^{\circ}\text{C}$ ). The 'Keitt' fruits were treated with 1 ppm 1-MCP in closed chamber ( $90 \times 90 \times 60 \text{ cm}^3$ ) at  $25\pm 1^{\circ}\text{C}$  for 24 hr and then left at room temperature for 7 days. The firmness values were decreased to 20 N after 7 days. The total soluble solids of the 1-MCP for 7 days induced a slight increase so the control. The firmness and total soluble solids were different but not significance between 1-MCP and control for 7 days. Ethylene production of mango fruits was significant different between 1-MCP and control whereas the respiration rate was not. In addition, the lightness, a, b, and C values were significantly increased with the control treatment during 7 days. So, the coloring of peel was inhibited by 1-MCP.

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## Introduction

Mango (*Mangifera indica* L.) cv. 'Keitt' is an exotic, sweet flavor, therefore, very appreciated fruit in Taiwan. However, this fruit is also perishable, highly susceptible to diseases, extreme temperature and physical injuries (Manica *et al.*, 2001). This mango cultivar, even when harvested before the onset of ripening, does not allow time for storage longer than a few days. Therefore, under normal storage conditions, ripening cannot be delayed sufficiently to allow for long distance transport. Thus, means of controlling its effects has to be developed in order to minimize postharvest losses.

Ethylene production in climacteric fruit, such as mango, is anticipated when fruit is dropped from the tree instead of being carefully picked. In contrast, increasing storage life and maintaining quality are directly related to maintenance of low ethylene levels (Fan *et al.*, 1999; Golding *et al.*, 1998; Jeong *et al.*, 2001). 1-Methylcyclopropene (1-MCP) is an inhibitor of ethylene perception that binds irreversibly to the ethylene-binding protein (Sisler and Serek, 1997) and preventing adverse ethylene responses in plant tissue for extended periods (Selvarajah *et al.*, 2001).

The objective of this work was to determine the effects of 1-MCP on changes in firmness, color, ethylene production, and respiration rate of 'Keitt' mango fruits.

## Materials and Methods

### Materials

'Keitt' mango fruits were harvested during the commercial harvesting season from an orchard in Tainan, Taiwan. Mango fruits were harvested in the maturity stages. They were graded for uniformity of shape and size. Blemished or diseased fruit were discarded.

### Treatments

Fifty mangoes were used experiment. One group of mango fruits from maturity stage was treated with 1ppm 1-MCP (Jiang and Joyce, 2000) for 24 hr at room temperature ( $25\pm 1^\circ\text{C}$ ). 1-MCP was applied as a gas, according to Fan *et al.* (1999) procedures. Mangoes from the treatment control (without 1-MCP) were also sealed in chamber under similar conditions. Upon removal from the chambers, fruits from each treatment were stored into paper box at room temperature during 21 days.

### **Quality properties**

Fruit color, firmness, total soluble solids (TSS), respiration ethylene, and production rate were evaluated. The color of the fruit was measured with a Lab Scan XE DP-9000 colorimeter (Hunter Associates Lab II, Preston VA). Mango samples consisted of two rings of approximately 1.5 cm obtained from the exterior of the fruit (on peel) was used for color measurements. The values of L (lightness), a (redness to greenness) and b (yellowness to blueness) were recorded for each sample.

The firmness of wedges was determined with a penetrometer (Fruit pressure tester, Italy). Firmness of 2 wedges per each fruit was determined, as force required for a 0.49 cm<sup>2</sup> tip to penetrate the widest part of the shoulder of the cut surface to a depth of 1 mm.

The total soluble solids (<sup>o</sup>Brix) were measured on mango juice using an Atago portable refractometer.

An infrared CO<sub>2</sub> analyzer (model UNOR 610, Maihak, Japanese) was used for CO<sub>2</sub> measurements in the exit air from the jars. A gas chromatograph (model GC-8A, Shimadzu, Japanese) with FID detector and alumina column was used to determine ethylene concentration in air samples taken from the exit air flow from the jars.

### **Data analysis**

The experiments were conducted in a completely randomized design. The mean values were analyzed by SAS version 9.1 (SAS, 2004). Data were expressed as the average of ten replications /treatment. Tukey's multiple range test ( $P \leq 0.05$ ) was used to discern between treatment classifications when F values were significant for main effects. Unless stated otherwise, only results significant at  $P \leq 0.05$  are discussed.

## **Results**

Differences in firmness decrease were observed between treatments (Fig. 1). At harvest, the firmness values were about 70 N. After 7 days, the firmness values were decreased to 20 N and similar between the treatments and control.

As shown in Fig. 2, initial TSS contents, excepted for control, were similar whatever the conditions. There was a slight increase which did match with the normal ripening process characterized by starch degradation to soluble sugars and increase in the soluble solid values. The TSS of the 1-MCP for 7 days induced a slight increase so the control with the same time.

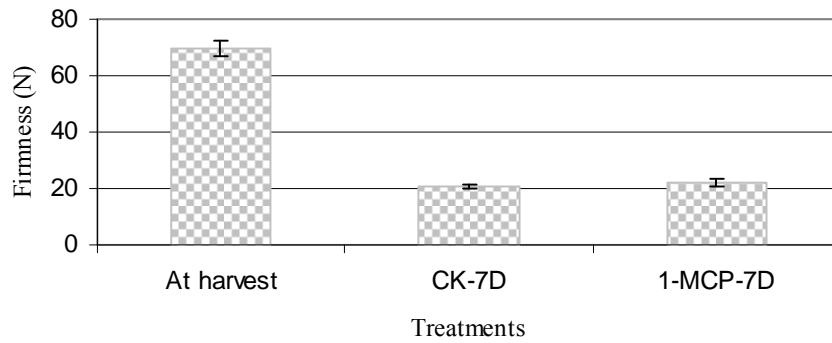


Fig.1. Effect of 1- MCP on firmness of 'Keitt' mango fruit

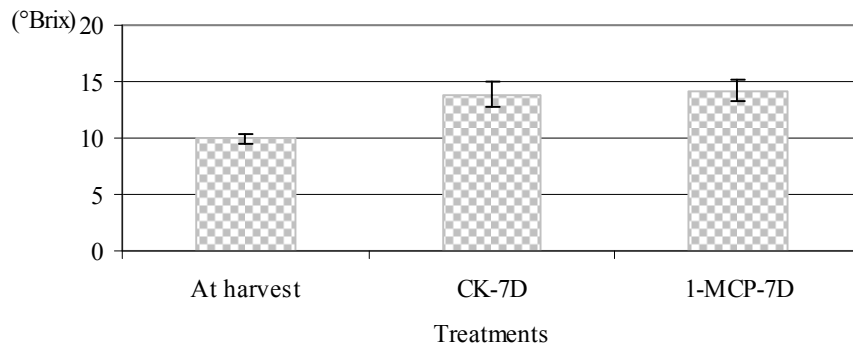


Fig. 2. Effect of 1- MCP on total soluble solid of 'Keitt' mango fruit

The results of respiration rate and ethylene production were shown in Table 1. The respiration rate of 1-MCP treatment for 7 days reduced not significant as compared to the other treatments, whereas ethylene production of 1-MCP treated fruit was significant of between treatments. The respiration rate was an indicator of metabolic activity and gives an indication of the potential shelf-life of the product. However, ethylene production results indicated that 1-MCP treatment could decrease the shelf-life by increasing ethylene production of whole mango fruits. The reason for the ethylene production must be the ripening of mango fruits before treating process.

Mango peel color was evaluated for objected color characteristics that primarily related to discoloration from post-harvest treatments (Table 2.). Data reported were the average of the controls and 1- MCP treatment held for hue angle (h). Fruits processed for 1-MCP exhibited higher lightness value throughout ripening compared with fruit processed for control after 7 days. This was indicated that these fruit did not develop as much color in association with using 1-MCP. The lightness, a, b, and C values were significantly increased with the control treatment after 7 days. In this test, the a and b values of CK and 1 –MCP after 7 days were higher control, and no any values of them were negative. Those were the reason the ethylene production of 1-MCP increased after 7 days.

Table 1. Respiration rate and ethylene production for 1-MCP treated of 'Keitt' mango fruits at room temperature 28°C

Treatments	C <sub>2</sub> H <sub>4</sub> (µl/kg/hr)	CO <sub>2</sub> (ml/kg/hr)
At harvest	0.46 c <sup>x</sup>	82.87
CK-7D	0.57 b	75.90
1-MCP-7D	0.62 a	56.50
Mean	0.55	71.76
F-value <sup>y</sup>	***	ns
CV (%)	0	14.46

<sup>y</sup> F-value for main effect or interaction significant at P<0.001 (\*\*\*).

<sup>x</sup> Values in columns followed by the same letter are not significantly different according to the Tukey test of transformed data.

Table 2. Color properties of mango as influenced by 1-MCP

Treatments	Peel color <sup>z</sup>				
	L	a	b	C	h
At harvest	72.63 a <sup>x</sup>	1.32 b	26.08 b	26.13 b	87.47
CK-7D	46.50 c	7.83 a	37.38 a	38.38 a	89.80
1-MCP-7D	52.10 b	8.13 a	40.32 a	41.18 a	78.70
Mean	57.07	5.76	34.59	35.23	85.32
F-value <sup>y</sup>	***	***	***	***	ns
CV (%)	11.88	38.14	22.05	21.24	34.90

<sup>z</sup>L = Lightness; C = Chroma,  $(a^2 + b^2)^{1/2}$ ; H = hue angle =  $\tan^{-1}(b/a)$

<sup>y</sup>F-value for main effect or interaction significant at  $P < 0.001$  (\*\*\*).

<sup>x</sup>Values in columns followed by the same letter are not significantly different according to the Tukey test of transformed data.

## Discussions

A novel gaseous compound, 1-methylcyclopropene (1-MCP) has been reported to inhibit ethylene action. 1-MCP has potential for the commercial control of ripening and senescence of harvested fruits and vegetables. There were significant differences on total soluble solid (TSS) between treatments in Fig. 2 on 'Keitt' mangoes. However, Santos *et al.*, (2004) were reported that the total soluble solid (<sup>0</sup>Brix) did not change independent from 1-MCP at 100 ppb during 24 hr, at room temperature ( $24 \pm 1^\circ\text{C}$ ) on 'Rosa' mangoes. Similar results were also found for 'Gala' apples (Fan *et al.*, 1999). Addition, Silva *et al.*, (2004) were also indicated that there were no differences for the TSS during 8 days storage at room temperature for evaluating storage period for 'Rosa' and 'Jasmin' mangoes with 1-MCP at 100 ppb during 24 hr, at room temperature ( $23 \pm 1^\circ\text{C}$ ).

Positive effects of 1-MCP in delaying ripening and maintain harvested product quality vary with plant genetic, physiological, and morphological characteristics (Sisler and Serek, 1997). The

study in herein, there were signification in firmness between treatments on 'Keitt' mangoes (in Fig. 1). Similar results were reported to delay fruit softening for 'Zihua' mangoes stored at 20°C for postharvest application of 1-MCP (Jiang and Yoyce, 2000). Studies over the last few years have also shown that 1-MCP can delay ripening and senescence of harvested products (Oliveira Neto, 2002; Cameron and Reid, 2001).

Ripening of climacteric fruits, such as mango, was initiated either by the natural evolution of endogenous ethylene (Mendonza Jr. and Wills, 1984). Color is one of the best ripening indicator for fruits. Silva *et al.*, (2004) were also reported that the color tended to progress during storage for 1-MCP but it started to decline from the day 4 for untreated fruit. That why was significant differences in the color including L, a, b, and C values in Table 2. The color was characterized by oxidation of skin pigments that became dull by the end of storage period.

It was interesting that, although 1-MCP did not always change respiration rate Table 1, but it was cause a increasing in ethylene production when compared with untreated fruits (Table 1). This would indicate that perception of ethylene was necessarily involved in firmness reducing in mangoes (Fig. 1). It is important to consider that the ethylene production of a fruit is also influenced by the harvesting conditions that may affect the maturity of the fruits. In some fruits (control and 1-MCP treatments), black spots in skin were occur during 2 weeks of the experiment. In addition, the non-uniformity in maturity levels among the fruits used in this study may have contributed to the differences in ethylene production and not data after 2 and 3 weeks.

## **Conclusion**

This study investigated the effect of 1-MCP on quality of 'Keitt' mango fruits. The data presented herein show that 1-MCP has potential for the commercial control of mango fruit ripening. Moreover, application of 1-MCP in combination with the use of paper box is feasible technology for ambient storage of 'Keitt' mango fruits. However, careful attention has to be harvest to treating the holding time because of the attendant risk of postharvest disease.

## References

- Cameron, A.C. and M.S. Reid. 2001. 1-MCP blocks ethylene-induced petal abscission of *Pelargonium peltatum* but the effect is transient. *Postharvest. Biol. Tech.* 22, 169-177.
- Fan, X., S.M. Blankenship and J.P. Mattheis. 1999. 1-Methylcyclopropene inhibits apple ripening. *J.Amer. Soc. Hort. Sci.* 124, 690-695.
- Golding, J.B., D. Shearer, S.G. Wyllie, and W.B. McGlasson. 1998. Application of 1-MCP and propylene to identify ethylene-dependent ripening process in mature banana fruit. *Post. Bio. Tech.* 14, 87-98.
- Jeong, J., D.J. Huber and S.A. Sargent. 2001. Influence of 1-Methylcyclopropene (1-MCP) on ripening and cell wall matrix polysaccharides of avocado (*Persea americana*) fruit. *Post. Biol. Tech.* 23: 1-15.
- Jiang, Y. and D.C. Joyce. 2000. Effect of 1-Methylcyclopropene alone and in combination with polyethylene bags on the postharvest life of mango fruit. *Ann. Appl. Biol.* 137, 321-327.
- Manica, I., I.M. Icuma, E. Malavolta, V.H.V. Ramos, M.E.Jr. Oliveira, M.M. Cunha and N.T. Junqueira. 2001. Tecnologia, produção, agroindústria, e exportação. Manga. Cinco Continentes, Porto Alegre, 617p.
- Mendoza Jr., D.B. and R.B.H. Wills. 1984. Mango: Fruit development, postharvest physiology and marketing in ASEAN. *Kuala Lumpur, ASEAN Food Handling Bureau*, 211p.
- Oliveira Neto, O.C. 2002. Fisiologia da maturação de três cultivares de bananas tratadas com 1-metilciclopropeno e armazenadas sob atmosfera modificada. *Centro de ciências Agrárias/UFPB, Areia*, 112p. (M. Sc. Dissertation).
- Santos, E.C.D., S.D.M. Silva, M. Rejane, N.M.A.F.D. Santos, I.R.B.S. Silveira, and L.P.D.Silva. 2004. Influence of 1-Methylcyclopropene on ripening and conservation of tree-dropped mango fruit cv.Rosa. *Acta Hort.* 645, 573-579.
- SAS, 2004. SAS User's Guide, Version 9.1.3. SAS Institute Inc., Cary, NC.
- Selvarajah, S., A.D. Bauchot and P. John. 2001. internal browning in cold-stored pineapples is suppressed by a postharvest application of 1-methylcyclopropene. *Post. Biol. Tech.* 23: 167-170.
- Silva, S.D.M., E.C.D.Santos, A.F.D.Santos, I.R.B.S. Silva and R.M.N. Mendonca. 2004. Influence of 1-Methylcyclopropene on postharvest conservation of exotic mango cultivars. *Acta Hort.* 645, 565-572.
- Sisler, E.C. and M. Serek. 1997. inhibitors of ethylene responses in plants at the receptor level: Recent developments. *Physiologia Plantarum* 100, 577-582.



## 1-MCP 對凱特芒果果實品質的影響

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關鍵字：1-MCP、芒果品質、'Keitt'芒果

**摘要：**本實驗之目的是為了探討'Keitt'芒果於室溫下處理 1-MCP 對果實品質之影響。'Keitt'果實於  $25\pm 1^{\circ}\text{C}$  環境下，以 1ppm 1-MCP 處理 24 小時後，於室溫下放置 7 天。常溫放置 7 天後，經 1-MCP 處理的果實，硬度會降低至 20N，而全可溶性固形物含量比對照組稍微高一點，但是和對照組相較之下，處理組果實的硬度與全可溶性固形物含量和對照組無顯著差異。處理組的芒果果實呼吸率和對照組之間有顯著差異，但乙烯釋放量則無顯著差異性變化。此外，對照組果皮的亮度、a 值、b 值及 C 值於 7 天後會顯著增加，但處理組果實轉色則會受到抑制。

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