

Influence of exogenous ethylene on the ripening of Harumanis mango

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Key words: mango, ethylene, ripening

Abstrak

Mangga Harumanis diperlakukan dengan 0, 0.1 dan 5 $\mu\text{L/L}$ etilena pada suhu 25 °C selama 24 jam. Penggunaan etilena pada kadar 5 $\mu\text{L/L}$ adalah mencukupi untuk melembutkan buah. Perbezaan pH dan jumlah asid tertitrat di antara perlakuan-perlakuan tidak ketara selepas buah menjadi lembut dalam masa yang sama. Buah boleh dimakan dalam tempoh 14 hari selepas menjadi lembut.

Abstract

Harumanis mangoes were treated with 0, 0.1 and 5 $\mu\text{L/L}$ ethylene at 25 °C for 24 hours. Ethylene at 5 $\mu\text{L/L}$ was enough to soften the fruit. There were no significant differences in the pH and total titratable acidity between the treatments within the same period after first softening. The fruit can be eaten within a period of 14 days after first softening.

Introduction

Ethylene accelerates the softening and ripening of fruit. Avocado fruit treated with either 10, 100 or 1 000 $\mu\text{L/L}$ ethylene softened at the same rate (Gazit and Blumenfeld 1970). Ripening of kiwifruit was stimulated strongly by ethylene at 5 $\mu\text{L/L}$ (Matsumoto et al. 1983). Honey Dew melons required an exogenous ethylene concentration of 3 $\mu\text{L/L}$ for induction of the respiratory climacteric (Pratt and Goeschl 1968) and for maximal eating quality the fruit must be fully matured at harvest and also must be given a supplemental treatment with ethylene (Pratt et al. 1977). Ethylene treatment on tomatoes of all ages caused a climacteric rise in respiration rate and hastened the development of red colour which is accompanied by softening and the characteristic tomato flavour and aroma (Lyons and Pratt 1964). Barmore and Mitchell (1976) showed that mangoes treated with 10–20 μL ethylene/L of air at 21 °C for 12–24 h under 92–95%

relative humidity and then shipped at 15.6 °C reduced the incidence of fruit rot and internal breakdown. This paper discusses the quality of Harumanis mangoes ripened with exogenous ethylene and the level of ethylene required for ripening mangoes commercially.

Materials and methods

Fruit

Preclimacteric Harumanis mangoes (*Mangifera indica* L.) were harvested from an orchard in Ipoh and transported by road to the laboratory in Serdang. The fruit were used within 24 h after harvest. They were washed in water and dipped in hot benomyl solution at 800 $\mu\text{g/mL}$ at 52 °C for 5 min to control diseases.

Treatment with ethylene

Three groups of four fruit were selected and each fruit was enclosed in a respiration bottle. Each group of fruit was then ventilated continuously with 0,

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0.1 and 5 μL ethylene/L of humidified air for 24 h at 25 °C. Earlier experiments showed that 5, 40, 70 and 400 μL ethylene/L of humidified air for 16 h and 24 h softened mangoes. This experiment, therefore, examined the treatment with a lower concentration of ethylene of 5 μL /L and below for a fixed time of 24 h. After the treatment, the fruit were ventilated continuously with humidified ethylene-free air at approximately 1 L/h per 100 g of fruit weight. The respiration rate was determined daily by measuring the carbon dioxide production using gas chromatography.

Three other groups of 52 fruit each were enclosed in a low-density polyethylene bag and placed in a 50-L plastic container also at 25 °C. Each bag had an inlet and outlet tube. The flow-rate for each inlet tube was respectively 28 L/h of 0, 0.1 and 5 μL ethylene/L of air. This flow rate was enough to provide an air change every 2 h to avoid accumulation of carbon dioxide. After the treatment, the bags were opened and the fruit exposed to air. Each fruit was examined daily for softening. Softening was determined by holding the fruit in the palm and assessing the resistance to finger pressure.

Carbon dioxide measurements

One-mL gas samples were taken from the effluent air and injected into a Varian thermal conductivity gas chromatograph fitted with a 1 800 mm x 3 mm stainless steel column packed with Porapak R with a helium flow rate of 30 mL/min.

Sensory evaluations and chemical analysis

Six trained panelists assessed mesocarp

colour, texture, sweetness, flavour and general acceptability of the fruit starting with fruit at the first day of softening. Subsequent assessments were carried out at 2, 4, 5, 6, 7, 8, 12 and 14 days on fruit with the same number of days after initial softening irrespective of when softening initially occurred. A hedonic 9-point rating scale was used with 1 = dislike extremely, 5 = neither like nor dislike and 9 = like extremely. One half of each fruit was used for sensory evaluation and the other half for chemical analysis of pH, total soluble solids (TSS) and total titratable acidity (TTA) by the methods of AOAC (1984). The TSS was expressed in percentage of anhydrous citric acid.

Results

By the end of the 24-h treatment period, only 44% of the 5 μL /L ethylene-treated fruit had sprung or softened but none of those treated with 0 or 0.1 μL /L ethylene had softened (*Table 1*). On the second day after treatment, 40, 58 and 92% of the 0, 0.1 and 5 μL /L ethylene-treated fruit respectively had softened. However, *Figure 1* shows that first softening of the four replicates treated with 5, 0.1 and 0 μL /L ethylene occurred after 1, 3 and 4 days respectively after treatment. Hence, for the 5 μL /L ethylene treatment, individual fruit softened earlier than the groups but for the 0 and 0.1 μL /L ethylene treatment individual fruit softened later than the groups.

Respiratory climacterics were detected in the control and 0.1 μL /L ethylene-treated fruit, but not in the 5 μL /L ethylene-treated fruit (*Figure 1*). The respiratory peak of the 0.1 μL /L ethylene-treated fruit occurred on the

Table 1. First softening of Harumanis mango after 24-h treatment with ethylene

Ethylene (μL /L)	First softening of mango (%)					
	1*	2	4	5	6	7
0 (Control)	0	40	92	96	98	100
0.1	0	58	94	98	100	100
5	44	92	98	100	100	100

*Days after treatment

Carbon dioxide production
(mL CO₂/kg per h)

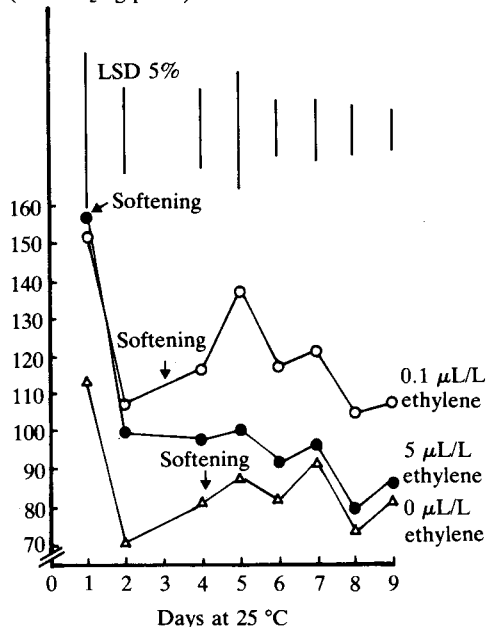


Figure 1. Respiration rates of Harumanis mangoes untreated and treated with two levels of ethylene for 24 h at 25 °C

fifth day which was one day earlier than the control fruit. The control and the 0.1 µL/L ethylene-treated fruit softened before the climacteric peaks appeared.

All the fruit were generally acceptable in the sensory evaluation test with a score of more than five (Figure 2) for the whole 14-day period after first softening. The pH increased gradually after first softening while the TTA decreased rapidly from first softening until the fourth day and from then onwards decreased gradually (Figure 3). There were no significant differences in the pH and TTA of fruit between treatments during the entire sampling period. The TSS increased in the first 4 days and then decreased (Figure 3). In the first 2–5 days, the TSS for control and 0.1 µL/L ethylene-treated fruit was significantly higher than that of fruit treated with 5 µL/L ethylene (Figure 3) and this is correlated with sweetness (Figure 2).

Discussion

Ethylene at 5 µL/L applied continuously for 24 h is enough to accelerate softening of Harumanis mangoes. This level is higher than the physiological level of 0.05 µL/L which caused metabolic activity (Burg and Burg 1962). Some fruits such as the slow ripening nectarine genotype P66–18 required longer ethylene treatment to produce the respiratory peaks. The peaks occurred on the fifth and sixth day after the continuous application of 10 and 100 µL/L ethylene respectively at 20 °C, but the preclimacteric could exceed one month without the exogenous ethylene (Brecht et al. 1984). Although Harumanis treated with 0.1 µL/L ethylene showed an earlier respiratory peak than the control, this level is not recommended for use in commercial ripening because of its slower softening action. Five µL/L ethylene is, therefore, found to be suitable for commercial application in the ripening of Harumanis mangoes. Softening of Harumanis mangoes preceded the climacteric peak. Similarly the softening of pears occur before and is independent of the climacteric rise in respiration (Wang et al. 1972).

There is no significant difference between treatments in the pH and TTA within the same periods after first softening although fruit treated with 5 µL/L ethylene softened earlier than the control and 0.1 µL/L ethylene-treated fruit. The sweetness, flavour and overall acceptability scores (Figure 2) and the TSS (Figure 3) of the control and 0.1 µL/L ethylene-treated fruit are significantly higher than the fruit treated with 5 µL/L ethylene between the second and the fifth day after first softening. Therefore, the higher TSS of the 0 and 0.1 µL/L ethylene-treated fruit in this period corresponds to the higher score of sweetness, flavour and acceptability. However, at the initial softening stage the sensory evaluation attributes of the 5 µL/L ethylene-treated fruit are preferred although the TSS between all treatments is not significant.

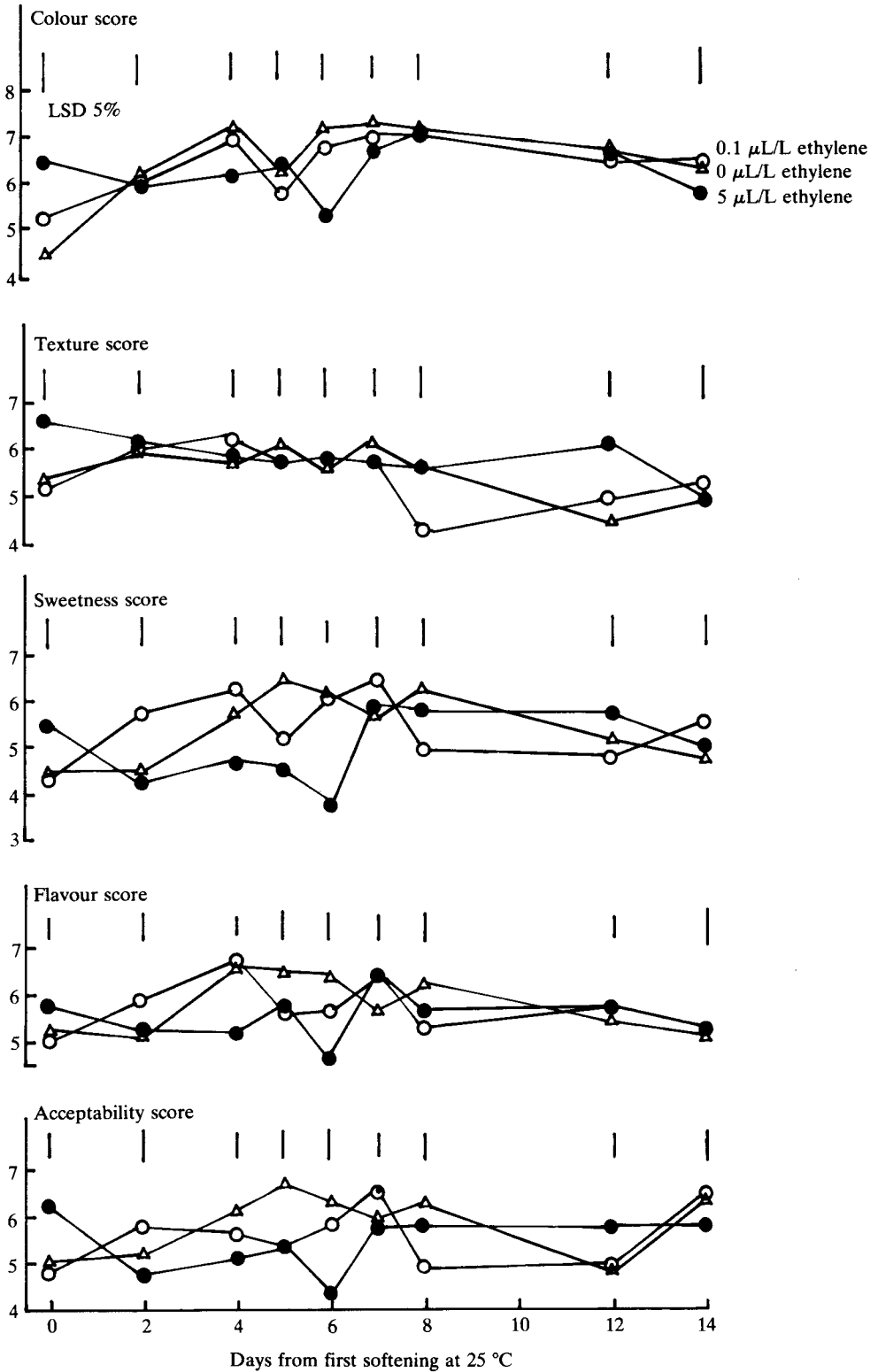


Figure 2. Score for sensory evaluation of Harumanis mangoes untreated and treated with two levels of ethylene for 24 h after different times from first softening at 25 °C

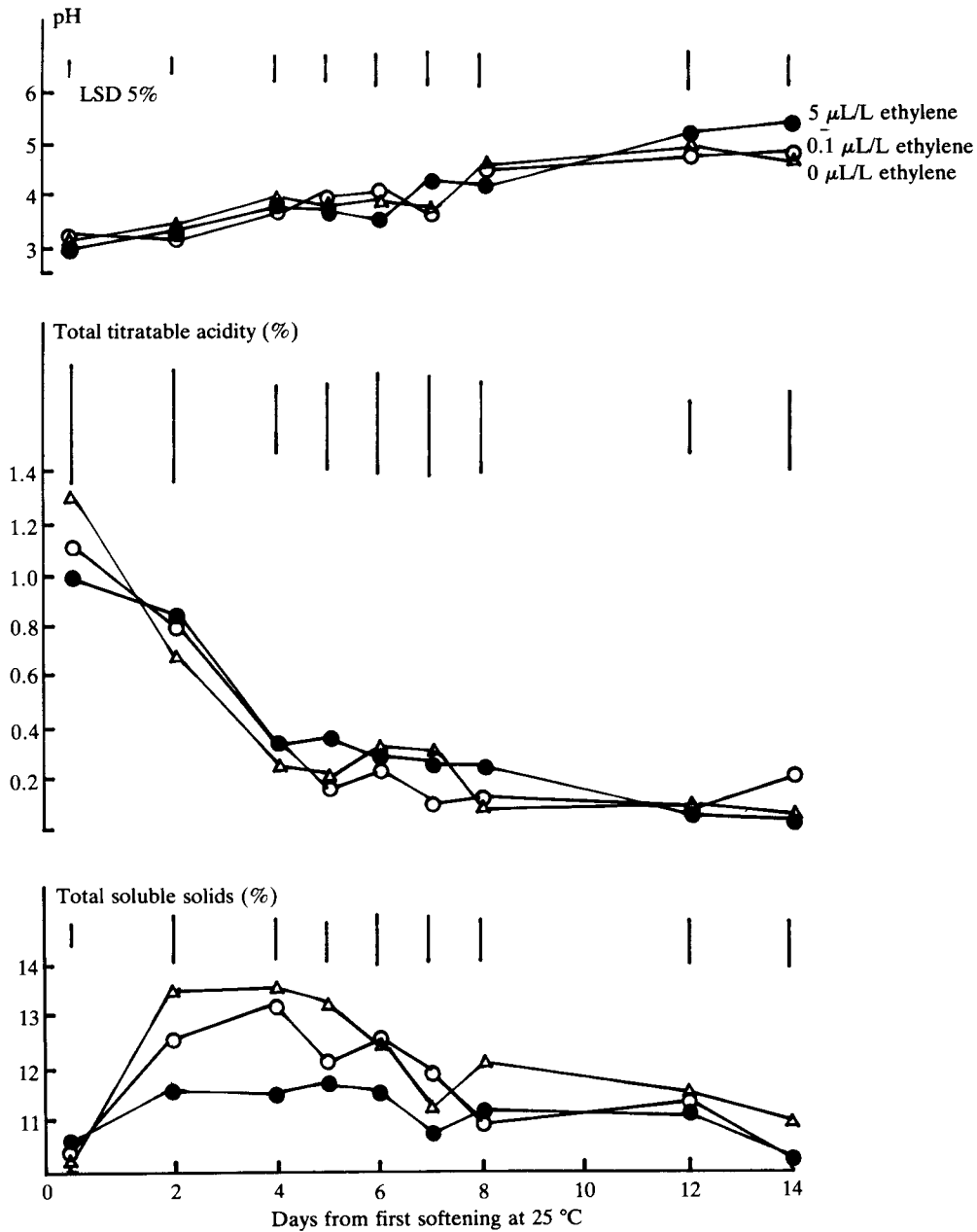


Figure 3. The chemical analysis of Harumanis mangoes untreated and treated with two levels of ethylene for 24 h after different times from first softening at 25 °C

The data indicate that 5 $\mu\text{L/L}$ continuous ethylene treatment of Harumanis mangoes for 24 h is enough to soften the fruit after treatment and may provide a commercial technique for ripening harvested unripe Harumanis mangoes.

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