MARDI Res. Bull. (1987) 15(1), (15–19).

RESPIRATION RATES AND ETHYLENE PRODUCTION OF RIPENING HARUMANIS MANGOES AFTER DIFFERENT CHILLING STORAGE PERIODS

P.F. LAM*

Keywords: Respiration, Ethylene production, Ripening, Mango, Chilling injury.

RINGKASAN

Buah mangga Harumanis yang telah disimpan pada suhu 7°C selama lima minggu dan dipindahkan ke suhu 20°C menunjukkan pernafasan klimakterik dan puncak etilena tetapi tidak pada buah yang telah disimpan selama enam minggu. Semua buah mengalami kecederaan sejuk dingin selepas penyimpanan pada suhu 7°C selama seminggu. Buah yang disimpan selama dua minggu pada suhu 12°C menunjukkan pernafasan klimakterik dan puncak etilena yang normal apabila dipindahkan ke suhu 20°Celsius.

INTRODUCTION

Mango (*Mangifera indica* L.) fruit when stored at 13°C and below did not show the climacteric during storage (KRISHNAMURTHY and SUBRAMANYAM, 1973; VELOZ, TORRES and LAKSHMINARAYANA, 1977). However, the fruit showed respiratory climacterics when removed to 20°C and 25°C and chilling injury symptoms were distinct. KRISHNAMURTHY and SUBRAMANYAM (1973) found that the respiratory rate of Pairi mango fruit at 10°C was quite steady throughout the 40 days of storage, but the rate suddenly increased and declined when the fruit were transferred to 20°C after 20 days of storage. VELOZ *et al.* (1977) showed that Kent mango stored at 8°C, 10°C and 13°C for 10, 16 and 22 days respectively had an extended trough of preclimacteric minimum which lasted throughout the storage period, but the fruit had a rapid increase in respiratory activity when they were transferred to the ripening conditions of 20°Celsius. All the fruit suffered chilling injury irrespective of the storage period at 13°C and below. This paper reports the respiration and ethylene production of Harumanis mango at 20°C after storing at 7°C and 12°C for various periods.

MATERIALS AND METHODS

Plant Material

Preclimacteric Harumanis mangoes were obtained from Perlis. The fruit were washed and dipped in 800 μg/ml benomyl at 52°C for three minutes to control diseases during storage.

Storage Temperatures

Twenty-four fruit were stored at 7°C and 12°C respectively. Four fruit were transferred from each storage temperature to 20°C at weekly intervals of six weeks for carbon dioxide and ethylene measurements. Each fruit was put into a 3.65-litre respiration bottle with a continuous in-let air flow-rate of approximately 1 litre/h/100 g of fruit. Each treatment comprised four fruit which represented four replicates. The occurrence of chilling injury symptoms was observed at each time of transfer. Control fruit were stored at 20°Celsius.

Chilling injury symptoms appeared as sunken grey black patches on the peel. The symptoms would appear during storage at the chilling temperatures or after exposure to 20°Celsius.

*Food Technology Division, MARDI, Serdang, Selangor, Malaysia.

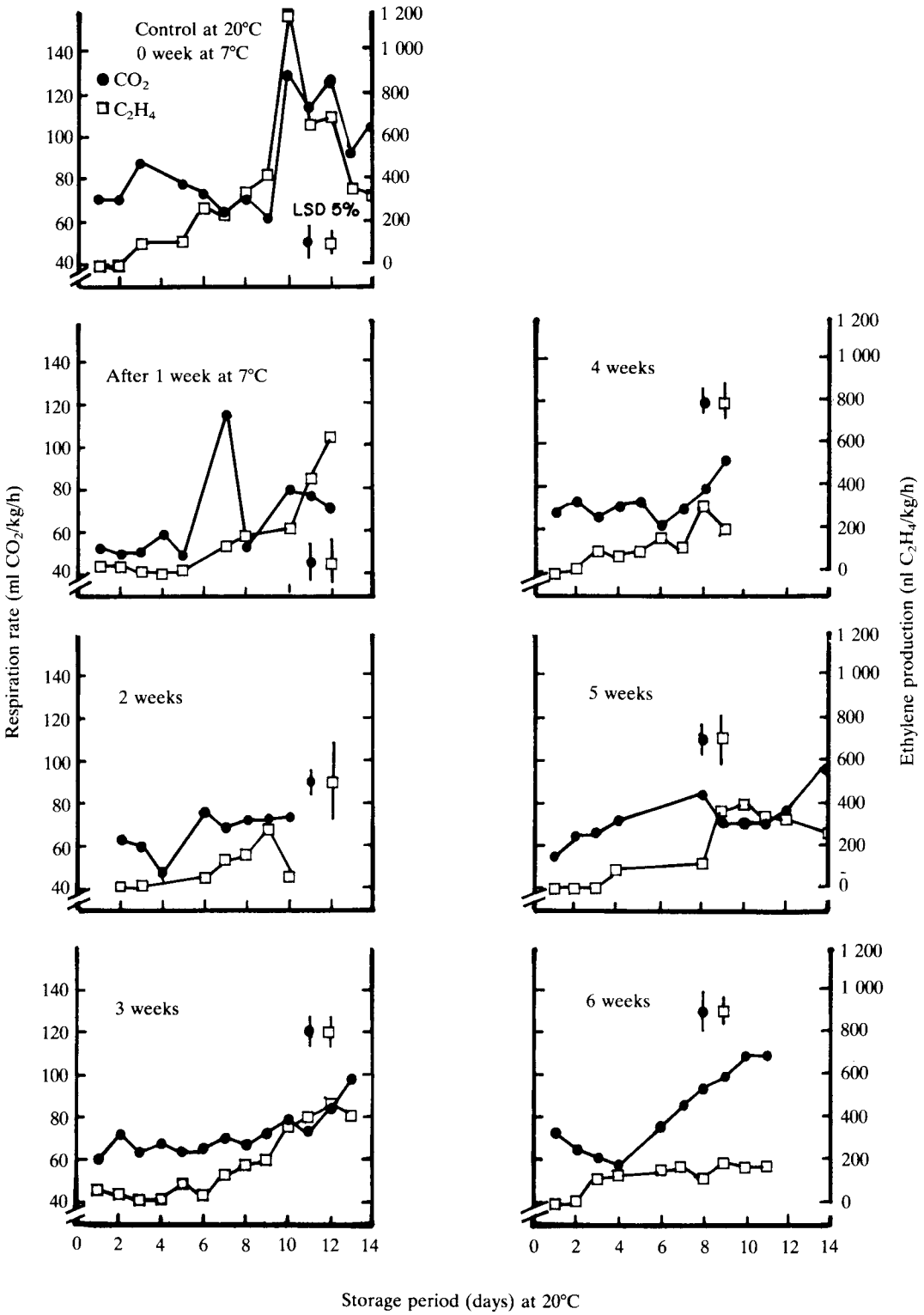

Figure 1. Respiration rates and ethylene productions of Harumanis mangoes at 20°C after being stored at 7°C for various periods.

Carbon Dioxide and Ethylene Measurements

One millilitre of respired gas was injected into a Varian 1420 gas chromatograph, fitted with a thermal conductivity detector and a stainless steel column of 150 cm x 3 mm packed with 80–100 mesh Porapak R, for carbon dioxide determination. For ethylene determination, one millilitre of respired gas was injected into a Varian 1440 gas chromatograph, fitted with a flame ionisation detector and a stainless steel column of 180 cm x 3 mm packed with 100–120 mesh Porapak T. Carrier gas for carbon dioxide was helium with a flow-rate of 30 ml/min and for ethylene was nitrogen with a flow-rate of 30 ml/minute. The column temperature was 35°C and 100°C respectively for carbon dioxide and ethylene determination.

RESULTS

Respiration Rates and Ethylene Productions

Harumanis mangoes after being stored at 7°C up to five weeks and exposed to 20°C showed respiratory climacterics and peaks of ethylene productions. However, these were not shown by fruit which were kept for six weeks *(Figure 1)*. All the fruit stored up to five weeks showed a small upsurge in carbon dioxide and ethylene production. Fruit stored at 7°C for one week, however, produced a carbon dioxide peak. The ethylene production for mangoes stored at 7°C for one week started to increase after ten days of exposure to 20°Celsius. Fruit which showed symptoms of chilling injury also had lower respiratory and ethylene peaks than the control. Fruit stored for one week at 12°C and exposed to 20°C also showed a respiratory climacteric *(Figure 2)*. There was a broad base for the climacteric peaks in fruit after storage at 12°C for two weeks. Fruit stored at 12°C for two weeks followed by exposure to 20°C showed an ethylene peak. An upsurge in ethylene production was observed in fruit stored at 12°C for a week followed by exposure to 20°C *(Figure 2)*.

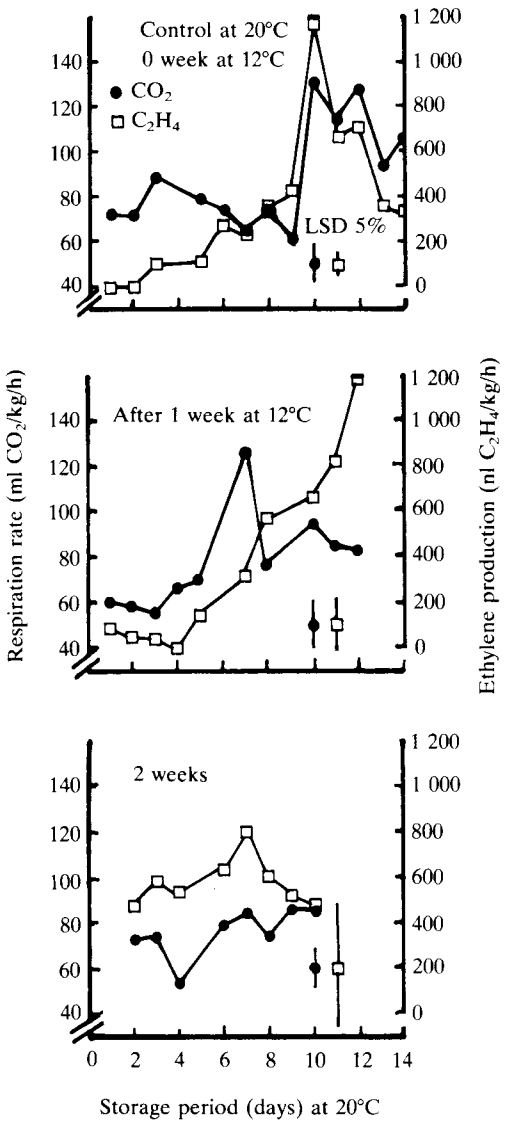

Figure 2. Respiration rates and ethylene productions of Harumanis mangoes at 20°C after being stored at 12°C for one and two weeks.

Physical Changes

Chilling injury symptoms were observed on fruit stored at 7°C for more than a week. The peel appeared dull green and had greyish-black pitted areas. These pitted areas were sunken. The fruit were firm and no disease were present before the transfer from 7°C to 20°Celsius. The

symptoms were more distinct after exposure to 20°Celsius. The prolonged storage at 7°C intensified the severity of chilling injury. The mesocarp of fruit stored up to four weeks at 7°C ripened to a light yellow colour. It became soft when exposed to 20°Celsius. The mesocarp was a blend of sweet and sour, and acceptable. However, the fruit stored at 7°C for six weeks were not acceptable after exposure to 20°C as they ripened abnormally. The peel appeared leathery and was black. The yellowish mesocarp was hard and had pockets of white tissues. The mesocarp had a rubbery-like texture and sometimes a fermented taste.

No chilling injury symptoms were observed on the fruit stored at 12°C for up to two weeks. Although samples were prepared for studies up to six weeks, the fruit could not be stored for more than two weeks at 12°C because disease infection of fruit had caused the termination of the storage-life. The fruit ripened normally when exposed to 20°Celsius. It was observed that all the fruit after being stored at 12°C and exposed to 20°C were affected by disease.

DISCUSSION

The Harumanis mango fruit showed respiratory climacteric and ethylene production peaks when stored at 7°C up to five weeks although chilling injury occurred after one-week storage. This showed that the injured fruit also exhibited respiratory climacteric and ethylene production peaks during ripening for a certain period of storage at the damaging temperature. However, when the chilling injury was severe due to prolonged storage at 7°C and subsequently exposed to a higher temperature, both the carbon dioxide and ethylene peaks were absent. This was similar to the respiratory and ethylene patterns of the Kent mango after chilling storage as shown by VELOZ *et al.* (1977). Similarly, EAKS (1983) found that Hass avocado fruit stored for zero and two weeks at 5°C and 10°C respectively exhibited the respiratory climacteric but not those stored for four and six weeks. Chill injured Harumanis mango had suppressed ethylene peaks after storage *(Figure 1)*. This pattern was also shown in the Hass avocado fruit (EAKS, 1983), but mango and avocado are contrary to pear in the level of ethylene production after chill storage. Pear requires exposure to 0°C and 5°C for initiating ripening (SFAKIOTAKIS and DILLEY, 1974). It produces more ethylene when transferred from cold exposure to a ripening temperature of 23°C than the fruits which are stored at 23°C directly.

The decrease in carbon dioxide and ethylene productions after the respective peaks was not shown by all mango fruit because of the presence of fungi. PRATT and MENDOZA (1980) observed that carbon dioxide increased in star apple when the fruit were decayed. Also ILAG and CURTIS (1968) showed that fungi produced ethylene.

The chilling injury symptoms in Harumanis mango are first observed on the peel. Slight and moderate chilling injury does not affect the mesocarp. The rubbery-like texture of the mesocarp is a characteristic of chilling injury in mango. The mesocarp also does not attain the orange colour of a normal ripened fruit. These characteristics were also observed in other mango varieties such as Pairi (KRISHNAMURTHY and SUBRAMANYAM, 1973) and Kent (VELOZ *et al.*, 1977). The cells of the mesocarp could be undergoing anaerobic respiration which causes the fermented taste. The results provide evidence that Harumanis mango fruit affected by chilling injury when transferred from the chilling temperature to a higher non-chilling temperature within a certain time of storage exhibits the respiratory climacteric and ethylene peaks. However, when chilling injury is severe due to longer exposure to chilling temperatures no respiratory climacteric and ethylene peaks are shown. This explains abnormal ripening in severely chill injured mango fruit.

ABSTRACT

Harumanis mangoes stored at 7°C for five weeks and transferred to 20°C showed the respiratory climacteric and ethylene peaks but not the fruit which were stored for six weeks. All fruit suffered chilling injury after one-week storage. Fruit which were kept for two weeks at 12°C showed the normal respiratory climacteric and ethylene peaks when transferred to 20°Celsius.

REFERENCES

EAKS, I.L. (1983). Effects of chilling on respiration and ethylene production of 'Hass' avocado fruit at 20°C. *Hort. Sci.* ***18***, 235–7.

ILAG, L. and CURTIS, R.W. (1968). Production of ethylene by fungi. *Science* ***159***, 1 357–8

KRISHNAMURTHY, S. and SUBRAMANYAM, H. (1973). Pre- and post-harvest physiology of the mango fruit: a review. *Trop. Sci.* ***15***, 167–93.

PRATT, H.K. and MENDOZA, D.B.JR. (1980). Fruit development and ripening of the star apple (*Chrysophyllum cainito* L.). *Hort. Sci.* ***15***, 721–2.

SFAKIOTAKIS, E.M. and DILLEY, D.R. (1974). Induction of ethylene production in 'Bosc' pears by post-harvest cold stress. *Hort. Sci.* ***9***, 336–8.

VELOZ, C.S., TORRES, F.E., and LAKSHMINARAYANA, S. (1977). Effect of refrigerated temperatures on the incidence of chilling injury and ripening quality of mango fruit. *Proc. Fla. State Hort. Soc.* ***90***, 205–10.

Accepted for publication on 19 February 1987.