PEROXIDASE ACTIVITY IN AVOCADO FRUIT STORED AT CHILLING TEMPERATURES

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ABSTRACT

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No increase in peroxidase activity was observed in 'Fuerte' avocado fruits which showed chilling injury symptoms as a result of storage at 0 or 2°C. Peroxidase activity in the fruit declined along with fruit softening during the ripening process. It is suggested that peroxidase acitivity in avocado fruit mesocarp has no role in the development of the chilling injury disorder appearing as dark patches on the skin of the fruit.

Keywords: avocado; chilling injury; peroxidase.

INTRODUCTION

Storage of avocado fruit, at temperatures lower than 10°C but higher than 0°C, for relatively long periods of time always results in the development of chilling injury. This physiological disorder has been described by several workers (Eaks, 1976; Chaplin et al., 1982; Couey, 1982; Van Lelyveld and Bower, 1984; Swarts, 1984). The most common symptoms are darkening of the skin and the appearance of gray or dark-brown discolouration of the mesocarp tissue. Recently, it was reported that in avocado fruit stored at 5.5°C for 31 days and kept under restricted ventilation conditions for 1 or 2 days the activity of polyphenol oxidase and of peroxidase in the mesocarp increased (Van Lelyveld and Bower, 1984), as well as fruit mesocarp discolouration.

Since chilling may involve oxidation phenomena, it was of interest to study peroxidase activity in 'Fuerte' avocado fruit, at different storage temperatures and during different storage periods, as related to chilling injury symptom development, changes in firmness, respiration and ethylene production.

MATERIALS AND METHODS

Fully mature (as determined by oil content) 'Fuerte' avocado fruits were harvested and on the same day were stored, untreated, in different well-ventilated refrigerated chambers at 0, 2, 5 or 20°C. The fruit was packed in ordinary commercial 4-kg cartons. At each temperature, five fruits were monitored individually for their respiration and ethylene production for 18 consecutive days in the cold storage and then at 20°C for ripening.
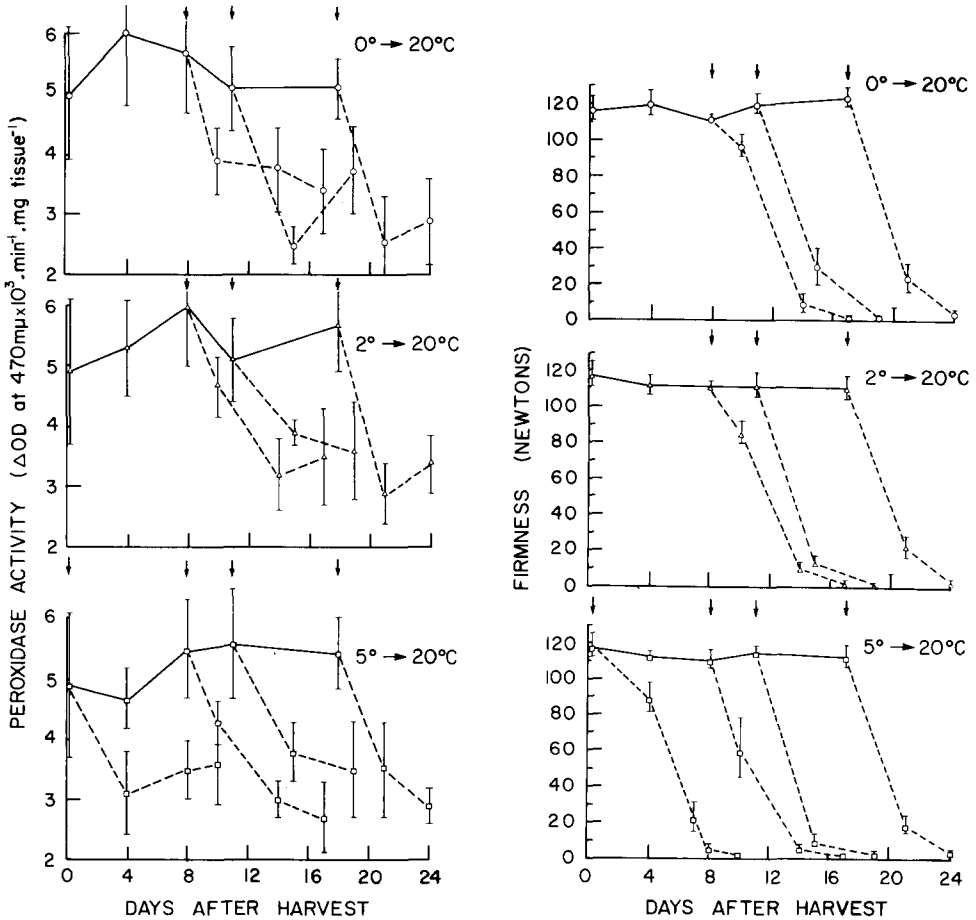

Fig. 1. Peroxidase activity in mesocarp of avocado fruit stored at 0, 2 or 5°C (————). Vertical arrows indicate the day of transfer of fruit to 20°C for ripening. Changes in peroxidase activity after transfer to 20°C (– – – –). Vertical bars indicate the standard deviation of five replicates.

Fig. 2. Firmness (pressure required to penetrate the mesocarp) of avocado fruit stored at 0, 2 or 5°C (————). Vertical arrows indicate the day of transfer of fruit to 20°C for ripening. Changes in firmness after transfer to 20°C (– – – –). Vertical bars indicate the standard deviation of five replicates.

Carbon dioxide and ethylene evolution were determined by gas chromatography in the headspace of 2-l jars inside which a single fruit was enclosed for 1 h. Periodically (after 8, 11 and 18 days), five fruits from each temperature were transferred to ripen at 20°C and tested for chilling-injury symptoms (dark patches on the skin of the fruit) and peroxidase activity in the fruit mesocarp (McCune, 1961). Fruit firmness was determined with a mechanized 'Chatillon' pressure tester, equipped with a conical tip, 6.5 mm in diameter. The pressure which was required to penetrate the fruit through the peel was recorded (Zauberman and Fuchs, 1973). All determinations were carried out in five replicates of a single fruit, and the standard deviation was calculated.

RESULTS

When avocado fruits were stored at 0,2 or 5°C for 18 days their peroxidase activity stayed at about the same level as at harvest time (Fig. 1). The same was true for the firmness of these fruits (Fig. 2). In all cases in which avocado fruits were transferred to 20°C, either immediately after harvest or after various periods of storage at 0,2 or 5°C, peroxidase activity in the mesocarp declined, as did the firmness of the fruit (Figs. 1 and 2).

The first chilling injury symptoms (darkening of the fruit skin) could be observed after 8 days of storage at 0°C or after 10 days of storage at 2°C, and the injury become more severe with time either in the cold storage or subsequently at 20°C (not shown in the figures). No such injuries were observed in fruits stored at 5°C for 18 days or in fruits kept continuously at 20°C from the first day after harvest.

The maximal rates of ethylene production were lower in fruits stored for 18 days at 0,2 or 5°C and then transferred to 20°C than in those which were stored at 20°C immediately after harvest (Table I). Similar trends can be observed for fruit respiration also.

TABLE I

Maximum rates of respiration and ethylene production of 'Fuerte' avocado fruits stored at different temperatures for 18 days and then transferred to ripen at 20°C. Numbers are averages of five replicates ± their standard deviation

Storage temperature (°C)	Maximum rate of respiration (mg CO_2 kg^{-1} h^{-1})	Maximum rate of ethylene production (μl kg^{-1} h^{-1})
20 continuously	187 ± 27	44 ± 19
5	109 ± 3	6 ± 4
2	132 ± 17	11 ± 8
0	140 ± 43	10 ± 3

DISCUSSION

The results (Figs. 1 and 2) show that peroxidase activity is related to avocado fruit ripening. When softening of the fruit was prevented, during storage at 0,2 or 5°C, no change in the relatively high peroxidase activity occurred. The lowest activity was always exhibited in the soft, ripe fruit. In mature green tomatoes stored in a modified atmosphere at 12°C, peroxidase activity was reported to remain unchanged during a period of 8 weeks (Goodenough, 1982). On the other hand, peroxidase activity was reported to increase as a result of mechanical injury or viral infection of the avocado tree bark (Da Graca and Van Lelyveld, 1978; Van Lelyveld and Bester, 1979). Also, Van Lelyveld and Bower, (1984) reported the enhancement of peroxidase activity in avocado fruit stored at 5.5°C and under restricted ventilation (low oxygen), and associated the phenomenon with initiation of avocado fruit mesocarp discolouration. They suggested that the increased peroxidase activity "may be associated with ethylene evolution".

In our study, no increase in peroxidase activity was detected at any storage temperature in spite of the fact that chilling injuries were observed at 0 and 2°C. However, in our experiments the chilling injury appeared as darkening of the exocarp (skin), similar to the description of Swarts (1984), rather than as dark-brown discolouration of the mesocarp as described by Van Lelyveld and Bower (1984). No anaerobic conditions prevailed in our experiments. Our data do not support the suggestion that increased peroxidase activity may be associated with ethylene evolution, as in Table I it can be seen that in cold-stored fruit the maximal rates of ethylene production (during subsequent ripening at 20°C) were significantly lower than in fruit stored continuously at 20°C. Also, in all cases (Figs. 1 and 2), the activity of peroxidase declined during ripening (softening); a stage at which ethylene is produced and evolved at the highest rates in avocado fruit.

Therefore, we conclude that peroxidase activity in avocado fruit mesocarp has no role in the development of the chilling injury disorder appearing as dark patches on the skin of the fruit.

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