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FACTORS AFFECTING THE ASSESSMENT OF AVOCADO RIPENESS

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Abstract

Firmness of avocado fruit, cv Hass, was assessed by hand, and by whole fruit compression and puncture tests using an Instron. The puncture test detected softening to a greater extent than the whole fruit compression test, but neither was as good as gentle hand squeezing by an experienced assessor.

Variability in softening and quality of ripe fruit was examined in relation to harvest date, tree effects, response to postharvest ethylene application, and rate of ripening. Both tree and harvest date influenced rate of ripening and internal fruit quality, and there was more variation within than between trees. Fruit which ripened rapidly were of better quality than those which ripened slowly, and different pathogens were isolated from rapid versus slow ripening fruit. The application of ethylene after storage accelerated ripening on only one of the three harvest occasions, and variability between fruit in both rate of ripening and internal quality was not reduced by this treatment. The incidence of rots was not consistently influenced by ethylene.

1. Introduction

The principal aim of our research is to improve ripe fruit quality of Hass avocados. Since fruit quality decreases markedly with increasing ripeness (Darvas et al., 1990), it is important to assess the quality of individual fruit at the same stage of ripeness. It is also important to examine different methods of assessing ripeness. Fruit firmness is the most appropriate method of determining ripeness. Generally, whole fruit compression (Swarts, 1981) or hand squeezing (Hopkirk et al., 1994) have been used.

Quality and shelf life of fruit can be affected by a large number of pre- and postharvest factors. With the cultivar Fuerte it has been found that fruit harvested later in the season have a decreased shelf life (Cutting et al., 1988), and high yielding trees produce fruit with a shorter shelf life and more internal browning (Cutting and Vorster, 1991). Hass fruit treated with ethylene 2 days after harvest, were found to ripen more uniformly and have a shorter shelf life than fruit ripened without ethylene (Gazit and Blumenfeld, 1970). In our study we have investigated the use of two instrumental methods to measure firmness and a number of factors which could affect variability between fruit including; harvest date, inter-tree effect, ethylene treatment and rate of fruit ripening.

2. Materials and Methods

2.1. Fruit material

Export-quality avocado *(Persea americana*, cv. Hass) fruit, were harvested from mature trees commercially grown in the Bay of Plenty, New Zealand on three occasions; 12 November

1991, 8 January and 3 February 1992. Fruit were harvested from the same 10 trees on each occasion, dipped in the fungicide Prochloraz (250 ppm a.i., 1 min), graded and packed into single layer trays, and 48 hours after harvest, placed into coolstorage at 6ºC for 7 days. Upon removal from coolstorage half the fruit were treated with ethylene (100 ppm at 20ºC for 24 h) and all fruit were ripened in trays at 20ºC. During ripening each fruit was assessed by gentle hand-squeezing by one trained assessor to gauge the state of ripeness. When each individual fruit was judged to be 'fully ripe' it was assessed for rots and disorders as described in Hopkirk et al. (1994). Analysis of variance was undertaken on angular transformations of the percentage of fruit with unacceptable levels of a disorder (>1.5 on a scale of 0-3); data presented are back-transformed means. Isolations of fungi causing rots were made onto potato dextrose agar from samples of diseased fruit, to aid identification.

2.2. Instrumental measurement of fruit firmness

Six days (seven for harvest 2) after removal from coolstorage, 40-80 ethylene- ripened fruit were assessed for firmness by gentle hand squeezing before using an Instron Universal Testing Machine to measure whole fruit compression and puncture force. Intact fruit were compressed 2 mm between 2 flat plates (traveling at a rate of 20 mm/min) at 3 locations around the widest pan of the fruit. Skin was removed from each of these locations, and a 7.9 mm diameter Effegi probe driven 8 mm into the flesh at a rate of 240 mm/min.

3. Results and Discussion

3. 1. Instrumental measurement of fruit ripeness

In general, results obtained using the Instron puncture test were slightly better correlated with hand assessment gradings, and less variable than results obtained using the whole fruit compression test (average R^2=0.19, standard deviation estimate for individual values (SD)=0.55, and R^2=0. 15, SD=2.06 respectively). Compression and puncture values obtained for the same fruit were not well correlated with each other (average R^2 for three harvests 0.34, SD=0.42). Compression values tended to be less variable both within and between fruit (i.e. lower coefficient of variation) than puncture values measured for the same fruit.

In conclusion, we feel that neither of the instrumental measurements of firmness used in this study were able to accurately reflect firmness as determined by gentle hand squeezing by an experienced assessor. While the Instron compression test appeared to be non-destructive, our experience was that the test caused some damage and additional softening, particularly when the fruit was already ripe. Both skin thickness and rots can influence readings obtained using an objective test, but a human assessor is able to make allowances for skin thickness and integrate fruit quality over the entire fruit surface rather than at specific points on the fruit.

3.2. Factors affecting fruit variability

Shelf life of naturally ripened fruit decreased during the season (Table 1). The incidence of rots and internal browning was similar on each harvest occasion.

On all three harvest occasions fruit from tree 9, and to a lesser extent tree 1, tended to ripen more quickly, have less rots and more internal browning disorders than fruit from other trees (data not shown). These cases where fruit from one tree tended to be consistently different from fruit from other trees were rare, due to the large amount of variability within a tree compared to

variability between trees (average coefficient of variation for incidence of rots in fruit from harvest 1 was 70.2% and 39.7% respectively).

We anticipated that treatment with ethylene would accelerate the ripening of the fruit considerably. In November, ethylene accelerated ripening at 20ºC by 1.8 days, but on the subsequent two harvest occasions, ethylene-treated fruit ripened no more quickly than fruit ripened naturally (Table 1). In addition, the spread of ripening and variability in the incidence of rots between individual fruit ripened with ethylene was no less than that in fruit ripened naturally. On two of the three harvest occasions *B. parva* was isolated mainly from the naturally ripened fruit and *C. gleosporioides* from ethylene-ripened fruit. Ethylene did not significantly influence the incidence of rots or internal browning disorders.

The incidence of both stem end and body rots increased as the time to ripen increased. For example, fruit from the second harvest which ripened after 6 days at 20ºC had an incidence of 5% stem end rots and 12% body rots, whereas fruit which ripened after 12 days had an incidence of 48% stem end rots and 73% body rots. On all three harvest occasions, rots in individual fruit which ripened first were predominantly caused by *Botryosphaeria parva* and most of the rots in late ripening fruit were caused by *Colletotrichum gleosporioides.* In general, *B. parva* was isolated with equal frequency from both stem end and body rots but *C. gleosporioides was* isolated predominantly from body rots.

In conclusion, it appears that the effect of ethylene is variable and differs during the season. Despite the fact that fruit were harvested from the same 10 trees on each harvest occasion, there was large variability between apparently similar individual fruit, which made it difficult to obtain consistent results for fruit treated in various ways. Our results have highlighted the importance of assessing fruit at the same stage of ripeness, to improve consistency of results in studies of factors affecting fruit quality.

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Table 1 - Shelf life, incidence of rots and flesh browning, in Hass avocado fruit harvested on 3 occasions, stored at 6°C for 7 days and then ripened at 20°C with or without ethylene (100 ppm at 20°C for 24 h). Values are means of 4 tray replicates separated in vertical columns by LSD at P=0.05.

Ripening method	Harvest date	Shelf life (days)	Rots (%)	Flesh browning (%)
No ethylene	12 Nov 1991	9.0*c*	33*ab*	-
(natural)	8 Jan 1992	9.1*c*	19*a*	18*a*
	3 Feb 1992	7.9*b*	40*ab*	14*a*
With	12 Nov 1991	7.2*a*	22*a*	-
ethylene	8 Jan 1992	9.2*c*	50*b*	13*a*
	3 Feb 1992	7.9*b*	21*a*	22*a*