Non-Destructive Evaluation of Post-Harvest Peach Fruit Softening

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Abstract

Peach fruit firmness was non-destructively measured by a drop-test device that produced serial measurements of the same fruits during post-harvest storage. Evaluations of post-harvest fruit softening were based on C2 values which were calculated as (peak impact force)/(time to impact peak force). The slopes of C2 values over storage time were used to compare softening between cultivars and within a cultivar harvested at 3 stages of ripening. The use of this device demonstrated the effects of harvest stage on post-harvest softening, with firmer fruit from the same cultivar generally softening at a faster rate than fruit harvested at a more advanced state of pre-harvest softening. Cultivar comparisons suggested the potential utility of non-destructive measurements in selecting genotypes with longer post-harvest storage life.

INTRODUCTION

The ultimate product of all tree fruit breeding programs is the fruit itself. The peach fruit must be of commercial quality regardless of tree characteristics, such as frost or disease resistance or improved tree form. Fruit sweetness, firmness, color and aroma have been found to be among the most important factors contributing to consumer acceptance in the marketplace (Bruhn, 1995) along with other factors including size (Fuller et al., 1990). The time of harvest has a major impact on these traits. Peaches harvested too early lack aroma, are low in sugars, and are generally smaller and less highly colored; all characteristics that negatively impact consumer acceptance (Frecon, 1988). Peaches are harvested based on a number of factors including size, ground color, and firmness. Of these factors firmness has been paramount because fruit must be firm enough to withstand the current harvesting and marketing practices. Since firmness is, as a rule negatively correlated with maturity, firmness at harvest affects all of the fruit traits that consumers use to judge quality. Peach breeding programs consider firmness at harvest, the ability to maintain firmness post-harvest, and the eating quality at various states of firmness as critical factors in evaluating selections for their market potential. Most of the information on peach firmness is based on unique samples of fruit taken at different times from the same tree. Fruit-to-fruit variability makes it difficult to accurately evaluate post-harvest firmness even with relatively large numbers of fruit sampled at multiple times.

Non-destructive drop testing has been the most widely used non-destructive technique to evaluate firmness (Delwiche et al., 1987, 1989; Meredith et al., 1990; Patel et al., 1993). In some, but not all, studies drop test data has been shown to correlate with destructive penetrometer measurements (Delwiche et al., 1987, 1989; Zhang et al., 1994). The objectives of this research were to evaluate the post-harvest firmness of peach genotypes using a non-destructive drop-test device and to evaluate the utility of non-destructive firmness testing in a peach breeding program to aid in the selection of firm, slow softening genotypes for cultivar development.

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MATERIALS AND METHODS

Fruit Firmness

Fruit firmness was measured non-destructively using an impact measuring device as described by Meredith et al. (1990) using suitable substitute electronic components.

Fruit Harvest and Evaluation

Eight cultivars were evaluated over a 3-year period. Trees were 5-10 years old, budded on to ‘Lovell’ rootstock. Standard practices of fertilization, weed, pest and disease control were uniformly applied to all trees. During the later stages of fruit development, trees were observed every 2-3 days to determine ripening progress. Trees were harvested three times as fruit maturity approached: 1) at the first appearance of ground color; 2) firm and fully colored; and 3) when fruit began to soften on the tree. The first two harvest stages were selected to simulate early and standard commercial harvests, while the third was similar to fruit harvested for local or roadside marketing. At these three sampling dates, twenty robust, disease-free fruit from the outer canopy at mid-canopy height were sampled. Each fruit was individually labeled to maintain its identification and its tree of origin prior to analysis of firmness.

Following harvest, fruit were immediately weighed, diameter measured, and “bounced” to record firmness (Fig. 1). Fruit firmness was recorded as a C2 value, that is the peak impact force/time to peak impact force (Delwiche et al., 1989). Following the initial post-harvest “bounce,” fruits were placed in a walk-in cooler at 0°C. Every three to four days, the fruit were taken from storage, allowed to reach room temperature (24°C) and re-bounced. Fruit that had signs of brown rot or other damage were removed from the study. Based on initial testing, if the average C2 value was below 9, the fruit were considered fully ripe. By evaluating fruit firmness over post-harvest storage time, a softening slope was developed. The inverse of this slope was termed the “softening index” (SI) and was used to compare cultivars. A low numeric SI indicated slow softening fruit while cultivars with a high SI softened relatively quickly in storage.

RESULTS AND DISCUSSION

Cultivar Comparisons

The SI, when comparing fruit harvested at the first picking, ranged from 0.20 for ‘Babygold’ to 1.12 for ‘Redglobe’ over the course of the study. The SI for most cultivars ranged from 0.50 to 0.80 (Fig. 2). Although softening rates for each cultivar varied over the years, those that were in the highest or lowest ranges generally remained so. For example, ‘Babygold’ the only non-melting flesh type consistently had the lowest SI (was the slowest softening genotype). The grouping of most cultivars between the 0.50 to 0.80 range may be attributed to the selection that is applied to commercial cultivars prior to release by breeders, and following release, by the market. This would eliminate rapid softening types and limit the variation in SI when evaluating commercial cultivars.

Effect of Firmness at Harvest

Firmness at harvest was correlated with the SI (r² = 0.74) over all cultivars. This correlation showed that fruit harvested at a firmer stage generally lost firmness more rapidly than fruit harvested at a more advanced stage of pre-harvest softening. Thus, the rate of softening depended on the firmness of the fruit when it was harvested (Fig. 3). When comparing cultivars and advanced selections, it would be important to harvest fruit at similar levels of firmness. We have found that this can be achieved by harvesting more than the number of fruit that will ultimately be tested, bounce testing the firmness of all of these fruit, and then selecting those that are most similar in firmness.

CONCLUSIONS

To make significant changes in the ability of peaches to maintain firmness, post-harvest breeders must be able to critically evaluate this characteristic. Non-destructive firmness testing appears to be a valuable tool, and this testing may be used to evaluate the genetic mapping studies for firmness, and for the evaluation of cultivars must not only possess high firmness, they must be sweet, highly flavoured, and have a strong aroma. With the relationship between firmness and fruit quality, we are currently utilizing non-destructive firmness testing.

ACKNOWLEDGEMENTS

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Literature Cited


Figures

Fig. 1. Non-destructive fruit testing device. A mechanical “arm” drops 0.5 cm on to a small impact force device.
firmness testing appears to be a valuable tool for this purpose. Non-destructive firmness testing may be used to evaluate new germplasm for potential use in breeding programs, for genetic mapping studies aimed at developing markers and isolating genes for firmness, and for the evaluation of advanced selections prior to cultivar release. New cultivars must not only possess firmness sufficient for harvest, handling, and storage but they must be sweet, highly flavored, and with acceptable texture. In order to investigate the relationship between firmness at harvest, loss of firmness post-harvest, and fruit quality, we are currently utilizing taste panels for sensory evaluation of bounce-tested fruit.

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Literature Cited

Figures

Fig. 1. Non-destructive fruit firmness evaluation apparatus. Fruit are supported by mechanical "arms" (A). When the arms are pneumatically opened (B) the fruit drops 0.5 cm onto a sensor that records a C2 value.
Fig. 2. Non-destructive measurements of post-harvest fruit softening of 'Sugar Giant' and 'Cresthaven' peaches. Fruit were soft ripe at a C2 of 9. SI = softening index, the inverse of the slope of the C2 values over days in storage.

Fig. 3. Non-destructive measure of firmness at first, second, and following the third harvests. Following the third harvest, the softening index, the inverse of the slope of the C2 values over days in storage.
Fig. 3. Non-destructive measurements of post-harvest fruit softening of ‘Bounty’ peaches, at first, second, and third harvest from the same tree. Note the reduced SI following the third harvest of softest fruit. Fruit were soft ripe at a C2 of 9. SI = softening index, the inverse of the slope of the C2 values over days in storage.