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Developing Critical Pitter Thresholds for Canning Peaches Using a Nondestructive Firmness Sensor

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Abstract

The relationship between mechanical pitting damage using the Atlas pitter (Atlas Pacific Engineering Co., Inc., Pueblo, Colorado) over a range of nondestructive and destructive firmness measurements for 'Andross', 'Carson', and 'Ross' clingstone peaches was studied. During the two years of work, the percentage of 'Andross', 'Carson', and 'Ross' fruit with pitting damage increased sharply as nondestructive firmness sensor Sinclair firmness index values fell below 7.0 (SFI) and when destructive penetrometer readings fell below 17 (SFI). Even though there was a low correlation between nondestructive and destructive firmness measurements, nondestructive measurements appears to be well related to the pitting damage. These preliminary results encourage that further research to improve the relationship between an automatic nondestructive system could give processors the option to segregate peaches susceptible to pitting prior to processing.

This information measured at the receiving area could be useful for subjective grading and/or predicting potential pitter problems during processing.

INTRODUCTION

High canning peach fruit losses occur during harvesting (Metheney et al., 2002) and processing because of physical damage such as bruising or fruit disintegration (Mitchell and Kader, 1989). Throughout the canning process, large amounts of fruit are damaged during mechanical pitting operations. Fruit disintegration is called pitting damage because it is produced during the pitting operation in the canning process. In a previous study (Metheney et al., 2002) a strong correlation between fruit firmness (UC penetrometer) measured in the weakest position on the fruit and pitting damage was established. The percentage of 'Andross', 'Carson', and 'Ross' fruit with pitting damage increased as fruit firmness fell below 18 N (4 lbf) for two growing seasons. This value was used as the reference critical pitter threshold (CPT) for damage in our present study, in order to develop a nondestructive CPT.

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MATERIALS AND METHODS

Three of the most important commercial canning peach cultivars ('Carson', 'Andross' and 'Ross') were selected to study the relationship between nondestructive firmness index values in fruit and pitting damage. All fruit were collected from the canning peach receiving area at Del Monte Plant No. 25 in Kingsburg, California at different times during the harvesting season. The fruit were transported to the F. Gordon Mitchell Post Harvest Laboratory at the Kearney Agricultural Center in Parlier, California, where nondestructive and destructive fruit firmness was measured at three equatorial positions on each fruit. Fruit were labeled at each site that firmness was to be measured and numbered using a permanent marker for identification after pitting. Fruit firmness was measured nondestructively using a bench top model of a commercially available, fruit firmness system (Sinclair Systems International, LLC, Campbell, California). The Sinclair index value is defined such that softer fruit are assigned lower index values than firmer fruit (0-100 units). Fruit firmness was destructively measured using the UC penetrometer with a 7.9 mm diameter tip.

After firmness measurements were made, fruit were transported to the receiving area of Del Monte Plant No. 25 in Kingsburg, California, where a commercially available mechanical cling peach pitter (Atlas Pacific Engineering Co., Inc, Pueblo, Colorado) had been installed for use during this experiment. Fruit were pitted and evaluated for damage.

For each canning peach cultivar evaluated, average Sinclair Firmness Index (SFI) values per fruit were calculated and rounded to the nearest whole integer. The percentage of fruit with pitting damage was calculated and presented at each whole integer of Sinclair firmness.

RESULTS AND DISCUSSION

After combining both the 2001 and 2002 seasons' data, comparison of mean cheek SFI values in the range of 2-21 with mean cheek UCP values between 4.5-63.5 N (1-14lbf) for 718 'Andross' fruit (Fig. 1, Panel 'A') revealed a significant, positive relationship between the two firmness measurements (P value = 0.001, SFI = 0.93 UCP + 5.53). However, the $R^2 = 0.54$ for the regression indicated a substantial amount of variation existed for the SFI values at each level of fruit cheek UCP firmness. The regression equation was plotted as a solid line for the data with 95% confidence intervals drawn as dashed lines for 'Andross' (Fig. 1, Panel 'A') for the combined 2001 and 2002 seasons. Using the regression equation and the CPT of 18 N (4.0 lbf), the calculated SFI critical pitter threshold (SFICPT) was 9.2 for 'Andross' fruit during the combined 2001 and 2002 seasons. Using the confidence interval lines as guides we can determine that at a given level of fruit cheek UCP firmness the SFI value has an error of $\pm$ 4.0. For example, at the fruit cheek UCP firmness of 18 N (4 lbf) (CPT) the SFI value was 9.2 $\pm$ 4.0 (SFICPT) for 'Andross' fruit during the combined 2001 and 2002 seasons, which was a SFI range of 5.2-13.2. There was a significant but low correlation between destructive and nondestructive firmness measurements for 'Carson' (Fig. 1, Panel 'B') and 'Ross' (Fig. 1, Panel 'C').

From regression analysis between the fruit cheek UCP firmness (destructive) and the SFI values (nondestructive) it was shown that the Sinclair bench top firmness system produced highly variable values when compared to the fruit cheek UCP firmness. In addition, predicted SFICPT values changed depending upon the cultivar and the season that data was collected.

The percentage of 'Andross', 'Carson', and 'Ross' fruit with pitting damage was plotted versus the nondestructive fruit cheek firmness measurements (Sinclair bench top firmness

system) for the 2001 season (Fig. 2, Panel 'A'), the 2002 season (Fig. 2, Panel 'B'), and both seasons combined (Fig. 2, Panel 'C'). Using data combined from both the 2001 and 2002 seasons, 16.3% of 'Andross' fruit were damaged during pitting (Fig. 2, Panel 'C') using the SFICPT (circa 9.0) as predicted by the respective regression equation, 4.8% of 'Carson' fruit were damaged during pitting using the SFICPT (circa 8.0) as predicted by the respective regression equation and 8.9% of 'Ross' fruit were damaged during pitting using the SFICPT (circa 8.0) as predicted by the respective regression equation. However, during the combined 2001 and 2002 seasons, damage of greater than 20.0% to fruit during pitting did not occur until SFI values were less than or equal to 6.0 for 'Andross', 'Carson' and 'Ross'.

From a practical point of view, Fig. 2 could be used efficiently by the canning industry after deciding the maximum percentage of pitting damage that would be allowed in the canning process (vertical axis). The intersection of the curve of pitting damage percentage with this threshold would mark the SFICPT in the horizontal axis; any fruit with a SFI lower than the SFICPT for a specific cultivar would be rejected. Then, by measuring the SFI of all of the fruits in the receiving area, individual fruit with a higher chance of suffering from pitting damage could automatically be discarded.

Despite the low correlation between destructive and nondestructive firmness measurements, we believe that the use of the relationship between nondestructive firmness and pitting damage is important to follow up. We are proposing some technical changes to improve the performance of this device. After these changes are included in the new Sinclair model, further research should be pursued to improve the relationship between nondestructive and pitting damage.

CONCLUSIONS

A significant correlation between nondestructive and destructive firmness measurements was established, but the level of the relationship was too low to establish a strong model. Thus, the Sinclair Firmness System (SFICPT) does not predict fruit damage during the pitting process as accurately as the UC penetrometer (UCP) fruit. It is clear that the Sinclair bench top unit needs improved precision before it can be used as an objective, fruit grading tool. Sinclair firmness index critical pitter thresholds were calculated using these correlation models, but they varied strongly depending on the cultivar and season.

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Figures

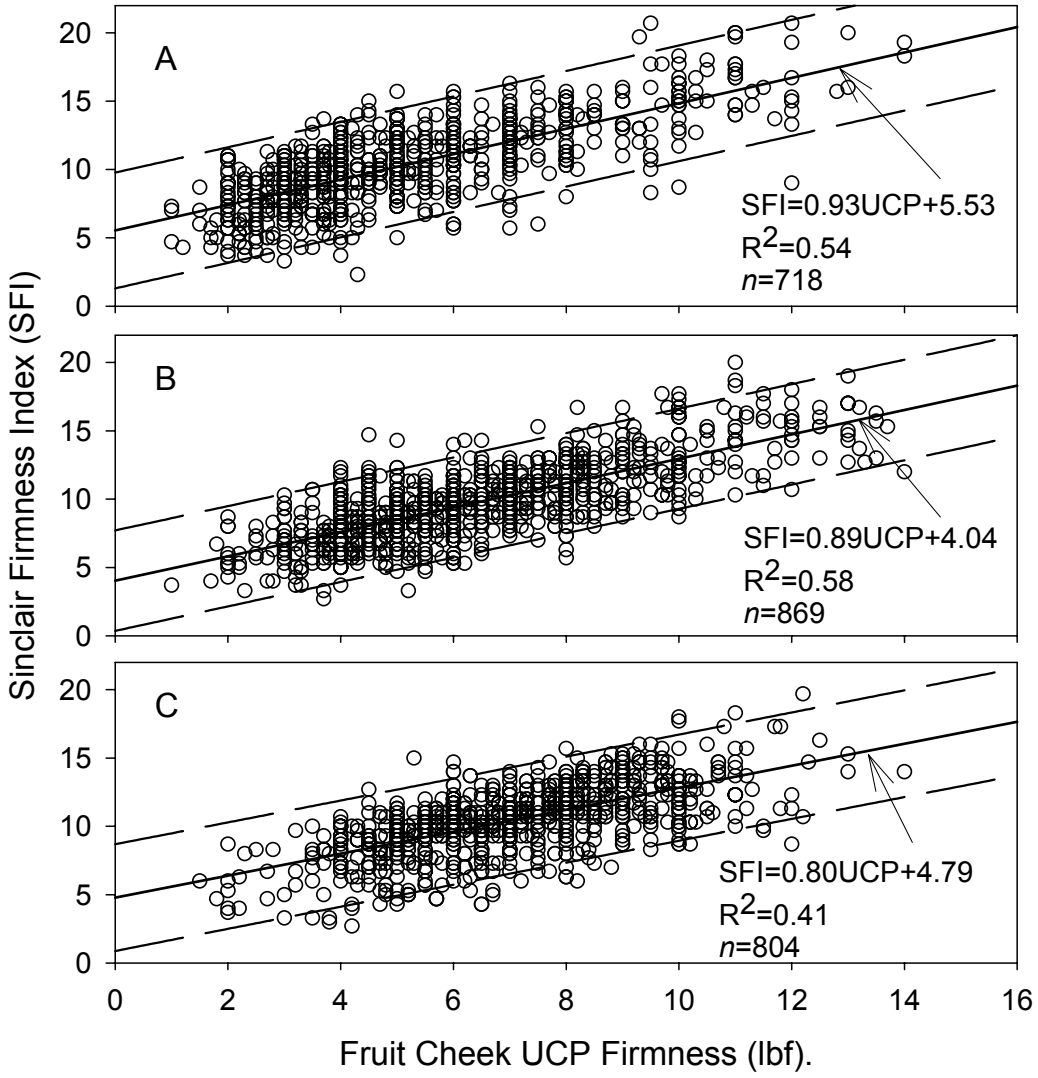

Fig. 1. The relationship between nondestructive Sinclair Firmness Index cheek firmness and destructive UC penetrometer cheek firmness measured for 'Andross' (panel A), 'Carson' (panel B) and 'Ross' (panel C) fruit for the combined 2001-2002 seasons. The solid line on each panel is the linear regression for the relationship, while the dashed lines about the regression line are the 95% confidence intervals for the SFI values.

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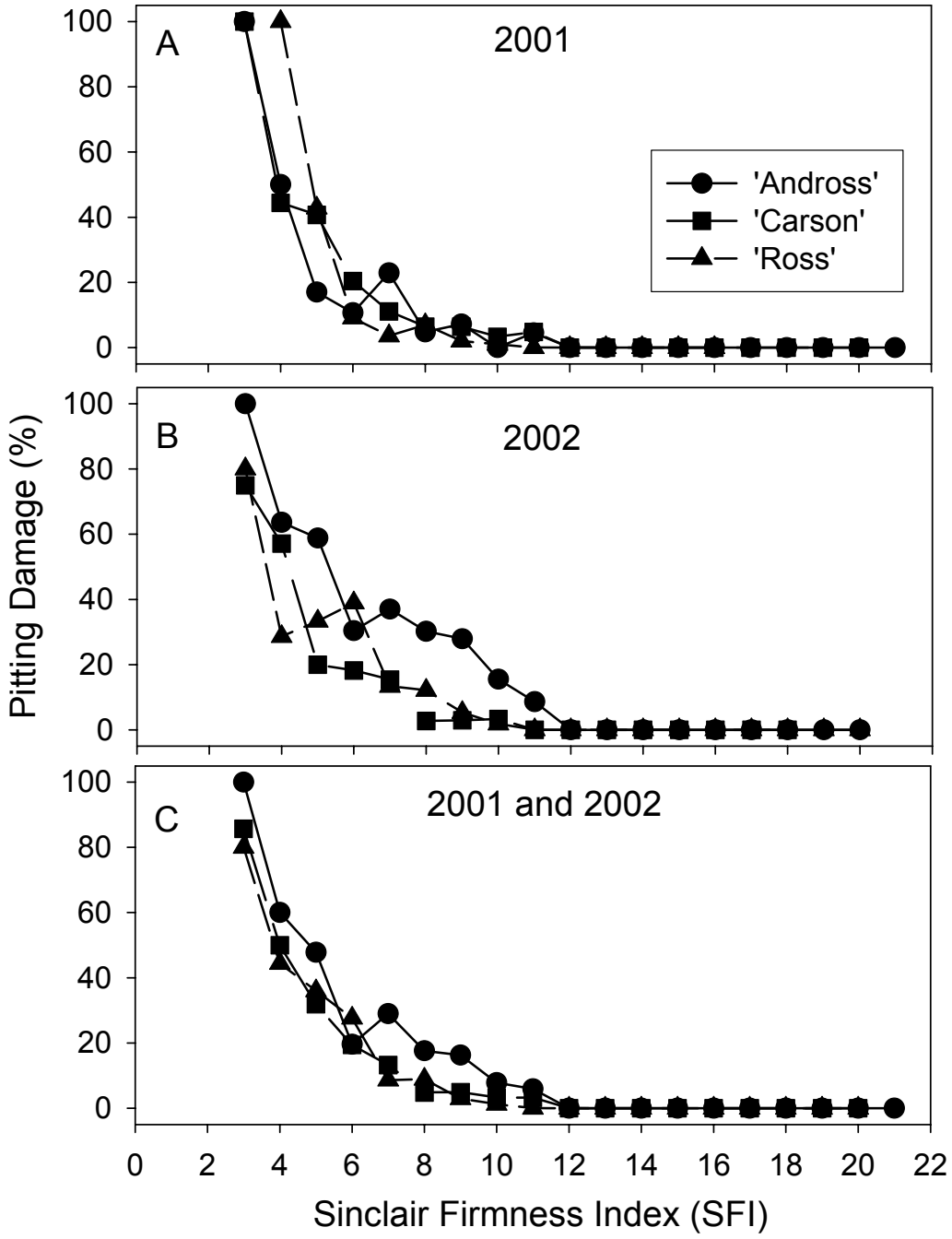

Fig. 2. The percentage of 'Andross', 'Carson' and 'Ross' fruit damaged during the pitting process for each level of nondestructive Sinclair Firmness Index fruit cheek firmness during the 2001 season (panel A), the 2002 season (panel B) and the combined 2001-2002 seasons (panel C).