Towards the development of a total soluble solids (refractometer) based maturity measurement and ripening prediction procedure for avocado fruit

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ABSTRACT

The relationship between the total soluble solids (TSS) content and the ripening homogeneity of SmartFresh treated avocado fruit was studied. The TSS content of the fruit displayed a tendency to shift towards a value of ±7.7 °brix during storage. The TSS content of fruit with a higher value than ±7.7 °brix decreased during storage while those with a lower TSS value tended to increase. When correlating the mean TSS values of the SmartFresh treated samples with the observed ripening variations, it was noticed that samples with a mean TSS value higher than 8.2 °brix ripened more evenly (after storage at 6 °C for 30 days) than those with lower readings. Most interestingly, the lowest individual fruit TSS readings in samples with a mean TSS of ≥8.2 °brix was 7.7 °brix. This supports the above observations. The procedure will be tested and further refined during the 2018 season and will also include controlled atmosphere treatments.

INTRODUCTION

The currently used moisture/dry matter content maturity measurement procedure has served the industry well for many years and a range of non-destructive measurement procedures are currently being tested (Magwaza & Tesfay, 2015). However, the methods have a major drawback in that they do not predict whether a specific consignment will ripen well enough to be used in a ripening programme.

Total soluble solids (TSS) measurements are used for a variety of sugar-based fruit. The method is especially suitable for non-climacteric fruit, and either a handheld or digital refractometer may be used. We have recently conducted a pilot trial aimed at establishing whether

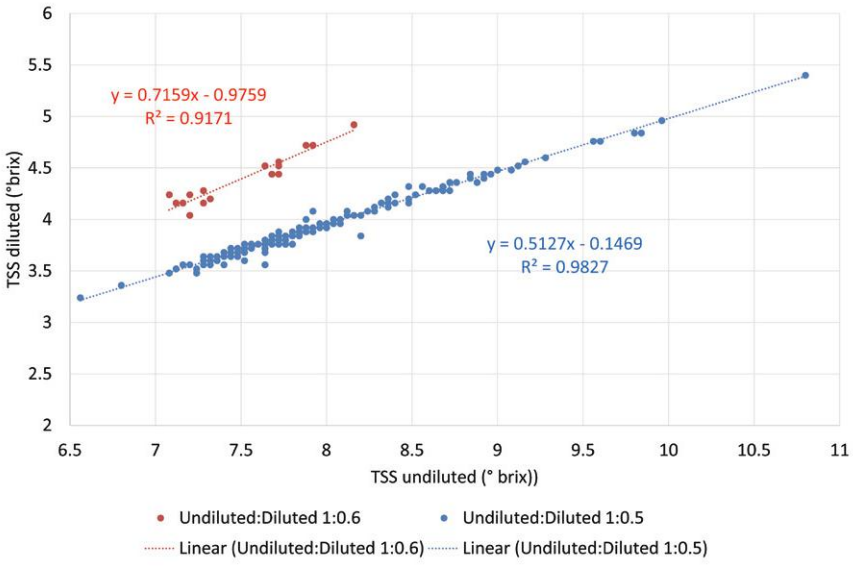

Figure 1: Relationship between the TSS content of undiluted avocado juice and the TSS content of juice samples that were diluted with an equal volume of distilled water.

the procedure has potential for predicting the ripening homogeneity of SmartFresh treated avocado fruit. We are of the opinion that the procedures being developed will have wider applications, which includes the screening of fruit selected for controlled atmosphere storage.

MATERIALS AND METHODS

Seven cartons of count 20 avocado fruit (various cultivars) were sampled during each SmartFresh application performed during the 2017 season at two packinghouses in the Tzaneen area. Six of the cartons (3 SmartFresh treated and 3 controls) were stored at different temperatures. The results obtained at the highest temperature (6 °C) were used in the present study.

The seventh carton (untreated fruit) was split into four groups of five fruit each and the TSS measured on, respectively, days 0, 7, 14 and 21. In each case, a sample of juice was diluted with an equal volume of distilled water and re-measured.

RESULTS AND DISCUSSION

The mean TSS contents of the batches were between approximately 6.5 °brix and 11 °brix on Day 0. As to be expected, the undiluted:diluted TSS ratio was 1:0.5 for most readings (Fig. 1). However, in a number of batches located at the lower end of the TSS range, the ratio was 1:0.6. This seems to indicate that in these fruit, a certain proportion of the soluble solids only went into solution after adding an equal volume of distilled water.

The mean TSS content of the 1:0.5 group was approximately 8.2 °brix at the time of harvest while that of the 1:0.6 group was around 7.5 °brix. During storage, the mean TSS content of the 1:0.5 group decreased from 8.2 °brix to approximately 7.7 °brix by day 21 (Fig. 2). Interestingly, during the same period, the mean TSS content of the 1:0.6 group increased from 7.5 °brix to around 7.7 °brix.

The reduction rate of the higher TSS content samples was approximately three times that of the rate of increase in the lower TSS content samples (-0.029 °brix per day versus 0.009 °brix per day).

This deductions imply that the TSS content of the fruit has a propensity to converge to a TSS level of around 7.7 °brix during storage/ripening. This was confirmed when plotting the mean TSS values of the individual samples separately (Fig. 3). The mean TSS of the samples that were higher than 7.7 °brix on Day 0 tended to decrease as the storage

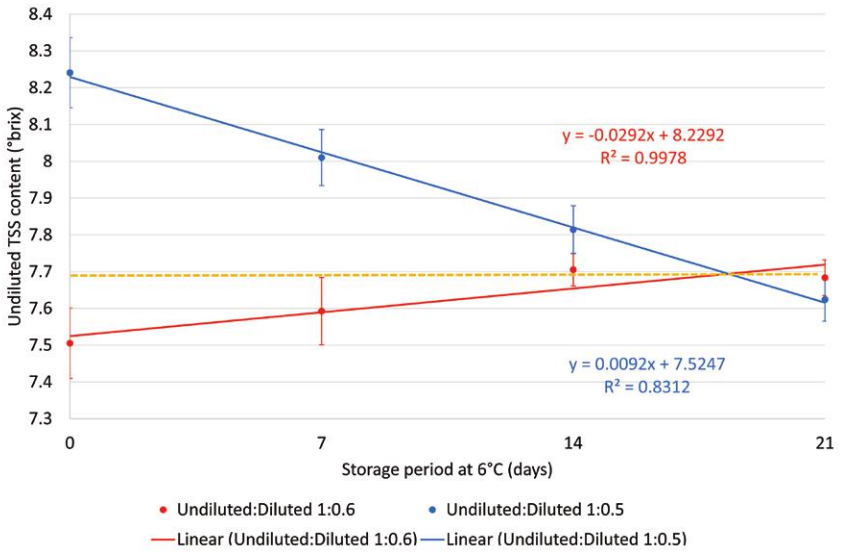

Figure 2: Changes in the respective mean TSS content of samples with undiluted:diluted TSS ratios of 1:0.5 and 1:0.6 that were stored at 6 °C for, respectively, 0, 7, 14 and 21 days. The dotted yellow line shows the TSS content where the two sets of samples converged.

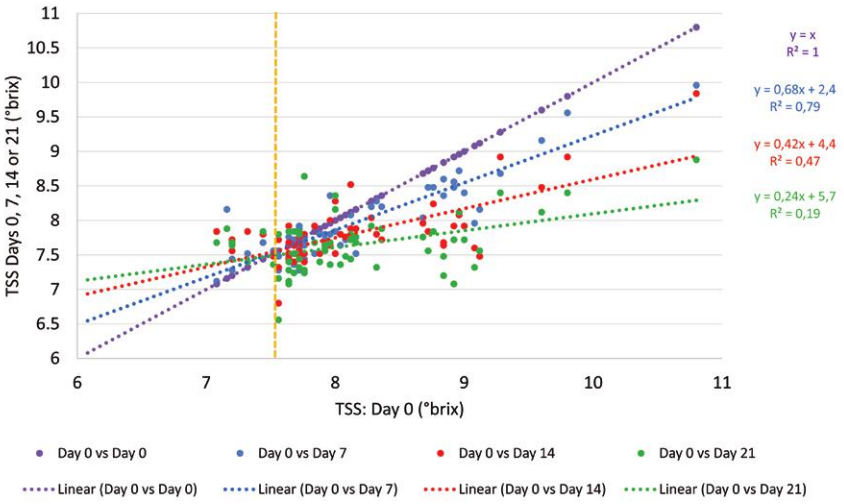

Figure 3: Mean TSS content of avocado fruit holdback samples taken during the 2017 season that were stored at 6 °C for, respectively, 0, 7, 14 and 21 days. The TSS readings of the Day 0 samples were plotted against, respectively, themselves, the Day 7 samples, the Day 14 samples and the Day 21 samples. The dotted yellow line shows the point where the TSS content remained at more or less the same level throughout the storage period. To the right of the yellow line, the TSS content decreased as the storage period lengthened. To the left of the yellow line, the TSS content increased as the storage period lengthened.

period got longer. On the other hand, the mean TSS of the samples that were lower than 7.7 °brix on Day 0 tended to increase as the storage period got longer. During the same time, the TSS content of the samples that were approximately 7.7 °brix on Day 0 remained around this level until Day 21. This caused the slopes of the regression lines to decrease as the storage period became longer. On day 7 it was 0.68; on day 14 it was 0.42; on day 21 it was 0.24.

Figure 4 shows the standard deviation of the mean ripening period for SmartFresh treated holdback samples that were stored for 30 days at 6 °C. The standard deviation remained under ±2 days provided that the mean TSS of the sample was higher than about ±8.2 °brix on day 0. In the cases where the TSS of the samples was lower than 8.2 °brix, the standard deviation measurements of the ripened samples were located between one day and three and a half days. Thus ripening was more uniform in samples with TSS <8.2 °brix at day 0.

The next step was to plot the TSS value of each individual fruit against the mean TSS value of the sample it originated from (Fig. 5). It was found that, in samples with a mean TSS content higher that 8.2 °brix, the TSS reading of the lowest fruit was higher than 7.7 °brix. This corresponds with the above observations.

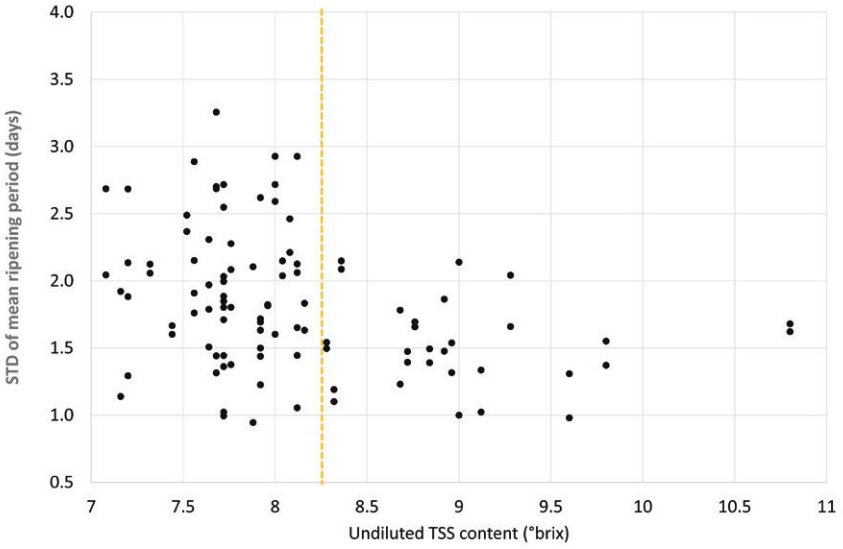

Figure 4: Standard deviations in the mean number of days required to ripen SmartFresh treated avocado fruit (after storage for 30 days at ±6 °C) plotted against the TSS content of the fruit.

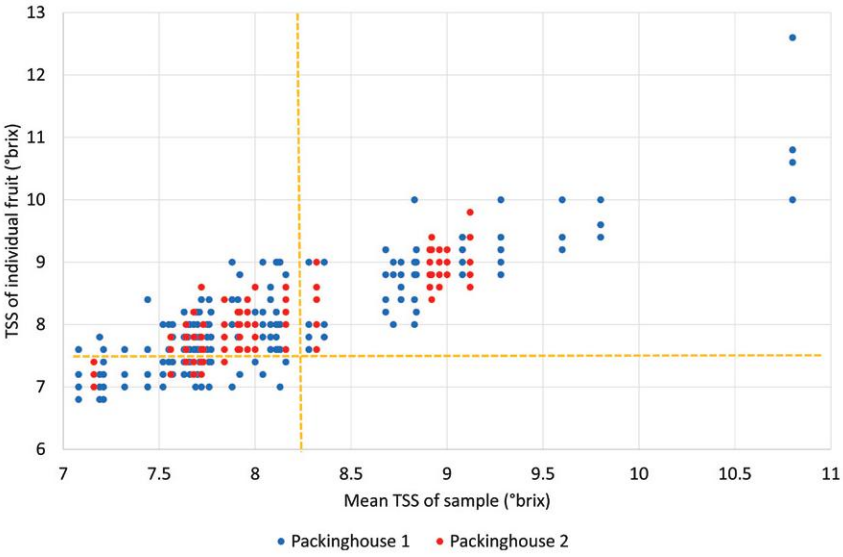

Figure 5: The TSS content of individual avocado fruit plotted against the mean TSS content of each sample. The vertical yellow line shows the minimum mean TSS recommended for pooled samples while the horizontal line shows the minimum TSS recommended for individual fruit.

Preliminary recommendations

- That the mean TSS content of SmartFresh treated avocado fruit destined for ripeners must be higher than 8.2 °brix.
- That the fruit with the lowest TSS content in the sample must be higher than 7.7 °brix.
- That the avocados be stored at the highest possible temperature regime appropriate for the cultivar and time of season.

Further research

The following research is suggested for the 2018 season:

- That the current trials be repeated.
- That an attempt be made to perform the trials over the whole season, including during periods when no commercial SmartFresh treatments take place.
- That a series of controlled atmosphere treatments also be included so as to determine the relevance and applicability of the present procedures.
- That larger TSS sample sizes (10 fruit) be used.
- That the TSS extraction method be refined so as to make it more user friendly.

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MAGWAZA, L.S. & TESFAY, S.Z. 2015. A review of destructive and non-destructive methods for determining avocado fruit maturity. *Food and Bioprocess Technology*, DOI 10.1007/s11947-015-1568-y