EVALUATION ALTERNATIVE METHODS OF BRUISE MEASUREMENTS IN APPLE FRUIT

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ABSTRACT

A study has been conducted to compare different methods to measure bruise susceptibility of fruit. In order to compare measured values with actual commercial bruising, an appropriate test method to simulate impact damage during handling was developed, employing a revolving tumbler.

From the analysis of bruise damage produced by the tumbler on four apple cultivars under different storage treatments, it was found that a large percentage of bruises were less than 1.5 cm^2 in area, and the number of bruises above 1.5 cm^2 did not change between treatments. It was concluded that laboratory measurements involving high impact energy levels may be insensitive as indicators of bruising levels on fruit during commercial operations. The impact loads produced by this method was very similar to those incurred by a practical grader, as indicated by Instrumented Sphere measurements. The tumbler test permitted examination of actual grader damage relationships with standard tests.

Three standard impact tests (vertical drop test, double and single pendulum test) were conducted on four cultivar apples: Splendour, Granny Smith, Pacific Rose, and Braeburn. Four different shapes of impact surface were used for each impact test. It was found that bruise susceptibility varied with different impact tests. Regression analysis was made on the data obtained from standard impact tests and tumbler test to find the correlation between the bruise susceptibility and the bruise area/apple.

Bruise susceptibility obtained from the vertical drop test using the hockey ball was closely related to the bruise area per apple produced by the tumbler test ($R^2 = 0.72$). The bruise factor obtained from the single pendulum test using the flat indenter also showed a correlation with the bruise area per apple produced by the tumbler test ($R^2 = 0.78$). However, the bruise susceptibility produced by the double pendulum test and single pendulum test was not well correlated with the bruise area/apple and bruise number /apple produced by tumbler test. The bruise susceptibility produced by using the pyramid indenters from three standard impact tests was not well correlated with the bruise area

per apple and the number of bruises per apple produced by the tumbler test.

Bruise susceptibility, bruise area, and the shape of the bruise depended upon the shape of the indenter used for the experiment and the method used to conduct the impact tests. Splendour, Granny Smith and Pacific Rose all had similar bruise susceptibilities, but Braeburn was significant less susceptible to bruising. Generally, bruise susceptibility increased with storage time in all cultivars. Apples stored in a low humidity environment (65% RH) generally had lower bruise susceptibilities after 2 months storage for the flat and hockey ball indenters but not for pyramid indenters on Splendour and Braeburn apples, when compared with 90% RH storage. Bruise susceptibilities at 0.5° C were higher than at room temperature. Fruit firmness also decreased with storage time.

Bruise shape depended upon the indenter surface shape. The flatter indenters produced bruises which were less deep than the hockey ball and pyramids. The bruise shape was elliptical for the flat plate, a circle for the hockey ball, and a rhombic for the pyramid indenters. There was no cracking below the bruise region for any apples when the flat plate indenter was used in the three standard impact tests. However cracks were found below the bruise region in Splendour, Pacific Rose, and Braeburn apple (but not for Granny Smith apples) when any pyramid indenter was used. The pyramid indenters produced a more linear relationship between a 2/3 power impact energy and bruise area (without skin removal) than either a spherical or a flat indenter.

Bruise visibility depended on the impact surface shape and energy levels. Some bruise produced from standard impact tests, when the flat indenter used, were not visible unless the apple skin was removed. Braeburn required a greater impact energy to produce an initial bruise than other cultivars. Once bruising began the visibility of bruising increased with an increase in energy levels.

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