Abstract

Fruit firmness is an important quality attribute of apples. It is important for consumer satisfaction, proper fruit storage, and shelf life. Therefore, it is considered a crucial parameter in the postharvest system. The Magness-Taylor pressure tester is widely accepted in the fruit industry for firmness measurement. However, it is destructive since it requires penetration of steel probe into the fruit flesh.The overall objective of this study was to develop a firmness tester that would be consistent with the Magness-Taylor measurement without causing fruit damage.

Since firmness is a measure of apple tissue strength in resisting probe penetration, the measurement of the bioyield strength of tissue was used to predict apple firmness. A mechanical probe composed of a cylindrical steel probe with rubber bonded at the end was pressed against fruit skin at a quasistatic rate, applying quasi-uniform pressure on the constant contact area. The Instron machine was used to detect the load drop due to the tissue failure.

A finite element (FE) model of the apple-probe contact was used to analyze the effect of various parameters on the contact stress distribution. It provided guidelines for designing the probe to produce a quasi-uniform stress distribution.

Based on the FE results, six probes were built and evaluated experimentally. The probes were pressed against the fruit at a constant speed. The Instron testing machine was programmed to stop when a small drop in the contact force was suddenly detected due to tissue bioyielding. The force at the bioyield point was well correlated to the MT firmness measurement.

The 1/4 inches diameter probe with 1/8 inches rubber thickness was found to be the optimal probe. It was repeatable, produced minimum damage, and had the maximum correlation coefficient with the MT firmness measurement of 0.853 in comparison with the 0.919 of the MT firmness measurements on apposite sides of the fruit.