Does the firmness vary within a single kiwifruit? Estimation of firmness distribution in individual fruit by compressed air deformation measurement

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Abstract

Firmness or ripeness of climacteric fruits, such as kiwifruit, is one of the most important quality characteristics. Estimating the firmness of kiwifruit during storage for ripening using a non-destructive method could be useful for consumers and distributors. Although several non-destructive firmness evaluation methods have been reported, we focused on a compressed air method based on the apparatus's simple measurement principle and mechanism. Here, we investigated the applicability of the compressed air method for estimating the firmness of kiwifruit during storage and determining the spatial distribution of measurable firmness in an individual kiwifruit. The deformations measured at different pressures ranging from 100 to 250 kPa revealed 200 kPa as the appropriate load pressure to measure the changes in kiwifruit firmness during storage at 20 °C. The elastic deformation of compressed air at 200 kPa roughly predicted and estimated the firmness determined by a conventional destructive evaluation with a high coefficient of determination (R^2 = 0.84) and root mean squared error (11 kPa). The findings suggested that the compressed air method at 200 kPa could track the changes in firmness over time because the fruits used for the measurement remained intact. Furthermore, the method successfully estimated the approximate spatial firmness distribution in one kiwifruit by measuring the deformation at 200 kPa and suggested that part of the kiwifruit began to ripen first. Overall, the findings suggest the potential of the compressed air method to understand the firmness distribution of individual fruits and elucidate the physiological changes after harvesting the fruits.