Firmness evaluation of postharvest pear fruit during storage based on a vibration experiment technique using a dielectric elastomer actuator

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Abstract

This study proposes a vibration technique based on the dielectric elastomer actuator (DEA) excitation to determine the resonance frequency of La France pear fruit. Postharvest pear fruit ripen during storage to improve their quality. A non-destructive measurement technique is necessary to predict maturity without damaging the fruit. The maturity of pear fruit is correlated with firmness, which can be assessed by a firmness index derived from the resonance frequency and the mass. Because DEAs exhibit characteristics that are conducive to vibration applications such as flexibility, lightweight, responsiveness, and deformability, they can be applied and effectively transfer excitation forces to fruit or vegetables with curved surfaces. In this study, the proposed technique is used to evaluate the variations in firmness indices of pear fruit during storage. Additionally, the firmness is measured using a penetrometer to verify the correlation with the firmness index. Using a vibration test system, the distinct frequency responses of pear fruit are obtained and the resonance peaks of the first elastic mode are observed around 700 Hz. The firmness indices of the target fruit are (21.6±2.5)×106 Hz^2 $g^{2/3}$ on day 0 and tend to decrease during storage. The tendency of each fruit is approximated based on a nonlinear least square method. Moreover, the firmness indices are well correlated with the results of the penetrometer test, demonstrating the effectiveness of the proposed technique to evaluate pear fruit quality.