Numerical analysis of disinfesting and quality of chestnuts during combined radio frequency and hot air heating based on single particle approach

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Abstract

Radio frequency (RF) heating has been considered as one of the most potential thermal treatment technologies to disinfest postharvest agricultural products. A three-dimensional model was established based on single particle approach using a finite element software, COMSOL, to analyze temperature distribution and product quality, and mortality of *Conogethes punctiferalis* in chestnuts during combined RF-hot air heating. The established model was verified by comparing the calculated average temperatures at three layers in the container, chestnut quality, and insect mortality with experimental results during RF-hot air heating. Because the relative percent error was less than 3%, the simulated average temperatures of three layers in the container matched the experimental results well. The equivalent heating time of *C. punctiferalis* slowly increased at ramp time but sharply at holding time, resulting in similar trend for the mortality of *C. punctiferalis*. The chestnut quality showed an opposite trend with the equivalent heating time and mortality of *C. punctiferalis*. The results showed that the 100% mortality of *C. punctiferalis* was obtained after RF-hot air heating to 50 °C with two mixings and holding for 3 min using simulation and for 5 min using experiment. No significant change was found in quality of treated samples since the change of color index (CI) was less than 5%. Using the verified model, the *C. punctiferalis* was completely controlled at 50 and 52 °C for holding a given time with acceptable chestnut quality. The verified model can help to optimize process parameters for RF-hot air or other thermal treatments in industrial-scale applications.