

Title Industrial-scale radio frequency treatments for insect control in walnuts
I: Heating uniformity and energy efficiency

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Abstract

Conducting industrial-scale confirmatory treatments is the final step in developing commercially and environmentally sound insect control technologies for in-shell walnuts using radio frequency (RF) energy as an alternative to chemical fumigation. Improving heating uniformity of in-shell walnuts in the industrial process is essential to ensure insect control without quality degradation. An industrial-scale 27 MHz, 25 kW RF system was used to determine the heating uniformity of in-shell walnuts. Non-uniform vertical temperature distributions were measured in the RF unit, indicating that mixing and circulated hot air were needed to obtain the required treatment uniformity. Using a uniformity index derived experimentally for the RF unit, we showed that a single mixing of the walnuts was required to optimize heating uniformity. The predicted standard deviation of walnut surface temperatures was verified experimentally. The average energy efficiency of two RF units in series was estimated to be 79.5% when heating walnuts at 1561.7 kg/h. This study provided the basis for subsequent evaluations of treatment efficacy and product quality needed in developing an industrial-scale RF process to control insect pests in walnuts.