RF TREATMENTS AS ALTERNATIVES TO CHEMICAL FUMIGATION FOR INSECT CONTROL IN NUTS

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Postharvest phytosanitation is essential for international and domestic commerce of tree fruits and nuts. However, current methods used in the industry rely on chemical fumigants that are either harmful to the environment or human health (Anon., 1995). The multi-billion dollar US tree fruit and nut industries are facing a major challenge in meeting more stringent regulatory restrictions and in addressing ever-increasing public concern over health and environment (USDA, 1999).

A multi-disciplinary (engineering, entomology, and fruit physiology) consortium was recently formed by university faculty and USDA scientists from states Washington, California, and Texas. We focus on developing effective thermal treatment protocols using electromagnetic energy especially in radio frequency (RF) range in combination with conventional thermal methods such as water or air heating to achieve a delicate balance between minimized thermal impact on product quality and complete kill of insect pests. In this presentation, we will discuss the general strategy of the research summarizing some of the major findings for this research.

Insect mortality data A clear knowledge of the thermal death kinetics of insects is essential. A heating block system was developed at WSU and used to determine the thermal death kinetics of the targeted insect pests. We found that the fifth-instar was the most heat resistant life stage and navel orangeworms were the most heat resistant insect as compared with codling moths and Indianmeal moths (Wang et al., 2001a&d). A thermal death kinetic model was established to predict the lethal time to reach different levels of mortality.

Fruit quality curves At elevated temperatures, product quality should be evaluated to ensure a practical treatment protocol. It is reasonable to describe a safe quality curve as a function of temperatures for different agricultural products as for the insect mortality. The quality curves for walnut and cherry were obtained based on chemical and sensory analyses. The treatment region between the lower part of the quality curve and the upper part of the insect mortality curve may guide the development of thermal quarantine treatments.

Dielectric property Knowledge of the dielectric properties of codling moth larvae and fruits will guide development of RF treatments. We have developed a new test cell that allows the frequency and temperature dependency measurement of dielectric properties of insect and host commodities. The dielectric property data may provide general information for selecting optimal ranges of frequency and the design of the thickness of the treated bed for uniform RF heating.

Heating uniformity Heating uniformity is a key for precise process control to avoid adverse

effect on commodity quality. The dielectric and ionic conductivity properties of the immersion water and that of fruit were matched to obtain a relatively uniform temperature distribution within and among fruits and nuts during RF heating (Ikediala et al. 2001; Wang et al., 2001c).

Differential heating By exploring the differences in the rate of heating between the insect pests and host walnuts, we can potentially reduce the time and product temperature needed for effective treatments, thereby reducing adverse effects on walnut quality, and allowing for a greater throughput of product through the equipment in the processing plant. When subjected to 27 MHz RF heating, a 1.4 to 1.5 times faster heating rate for insects than for walnut kernels was found. Preferential heating of insects in walnuts at RF frequency would enhance the possibility to develop a thermal treatment that can effectively control insects without adverse effect on product quality.

Preliminary results on process protocol for walnuts Walnuts in the shell were treated with RF energy in a 27 MHz pilot-scale system to determine the treatment effect on codling moth mortality and walnut quality (Tang et al., 2000; Wang et al., 2001b). After 2 and 3 min of RF treatments, infested in-shell walnuts were heated to 43 and 53°C. The corresponding insect mortality reached 78.6 and 100%. The concentration of fatty acid (FA) of treated walnuts was not affected by RF treatments. The FA values were <0.1% after accelerated storage times up to 20 days at 35°C, simulating storage at 4^{o}C for up to 2 years. The effect of RF treatments on walnut oil peroxide values (PV) was not significant. The PV value of walnuts was less than the 1.0 meq/kg (the upper limit for good quality walnuts), after 20 days storage at 35^{o}C that simulated 2 year storage at 4^{o}C. RF treatments can, therefore, potentially provide an effective and rapid quarantine security protocol against codling moth in walnuts as an alternative to methyl bromide fumigation.

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