RADIO FREQUENCY HEAT TREATMENTS TO DISINFEST DRIED PULSES OF COWPEA WEEVIL

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Dried pulses, such as chickpeas, green peas or lentils, are valuable export commodities in the US Pacific Northwest. A major problem in the marketing of these products is infestation by insect pests, which may cause importing countries to require phytosanitary treatments before shipment. Typically, chemical fumigants are used to disinfest product, but regulatory issues, insect resistance, environmental concerns and the increase of the organic market have caused the industry to explore non-chemical alternatives. One possible alternative is the use of radio frequency (RF) energy to rapidly heat product to insecticidal levels. This paper reports preliminary results from our investigation into the potential of the non-chemical treatment method to control insect pests in dried pulse products.

Materials and Methods.

Determining most heat tolerant stage: The relative heat tolerance of cowpea weevil stages was determined using a computer-controlled heat block system designed by Washington State University (Ikediala et al. 2000, Wang et al. 2002). Cowpea weevils were treated in mung beans, a small legume that fit within the heat block and provided relatively rapid heat transfer. Adult cowpea weevils were allowed to oviposit on clean mung beans for 24 hours. Infested mung beans were treated 2, 7, 15, and 21 days after infestation when developing cowpea weevils were in the egg, young larval, old larval and pupal stage, respectively. Treated mung beans were held for adult emergence. All stages were treated at 50°C for 50, 100 and 150 min, 54°C for 7, 14, and 21 min, and 58°C for 1, 2 and 3 min. About 100 adult weevils in flat nylon screen bags were also treated at the above temperature/time combinations. Because adults were completely killed at these treatments, adults were also treated at 48°C for 50, 100, and 150 min, 52°C for 4, 5 and 6 min, and 56°C for 0.5, 1 and 1.5 min.

Dielectric property measurements: Immature stages (a mix of late larvae and pupae) were dissected out of black-eyed peas, while adult weevils were removed from laboratory cultures. Both immature stages and adults were killed and stored at -20°C until they could be shipped to Washington State University for measurement. Dielectric measurements of cowpea weevils were made using the open-ended coaxial probe technique with an impendence analyzer over a frequency range of 10-1800 MHz (Wang et al. 2003). Measurements of the dielectric constant (ε') and loss factor (ε'') were made at 20, 30, 40, 50 and 60°C. The results were compared to similar values obtained for chickpeas, green peas and lentils (Guo et al. *in press*)

Results and Discussion.

Most heat tolerant stage: Among the immature stages, the most heat tolerant stage appears to be the pupal stage (Fig. 1). Eggs were quite susceptible; however, this may be due to the eggs being more directly exposed to heat. Larval and pupal stages, being internal to the bean, were more insulated from the heat, experiencing a shorter exposure to lethal temperatures. Adults were less tolerant than immature stages; at the temperatures and exposures used to treat immature stages, there was no survival of treated adults. When comparing adult mortality to larval and pupal stages, the difference may again be due to the insulating effect of the bean. However, adults were also less tolerant than eggs, which were more directly exposed to heat. Mortality from less extreme temperature-time combinations (Fig. 2) showed that adult weevils, while less tolerant than immature cowpea weevils, were more tolerant than most dried fruit and nut pests (Johnson et al. 2003).

Dielectric properties: The dielectric constant (ε′) and dielectric loss (ε″) for cowpea weevil immature stages (larvae and pupae), adults increased with increasing temperature (data not shown). At frequencies commonly used by industry for RF heating, dielectric loss for both insect stages was higher than that for lentils (Fig. 3), chickpeas and green peas (Guo et al. *in press*), suggesting that cowpea weevils would heat at a faster rate than the product.

Conclusions

Although cowpea weevils infesting beans appear to be relatively heat tolerant, preliminary studies indicate that chickpeas, green peas and lentils can tolerate RF treatments to 60°C for 10 minutes without adverse effects on quality (Wang unpublished data). This, along with deep penetration depths of these products found at RF frequencies (Guo et al. *in press*) suggest that practical large-scale industrial treatments should be possible. However, more research is needed to identify the optimal treatment parameters, and confirm insect mortality under RF treatments.

References:

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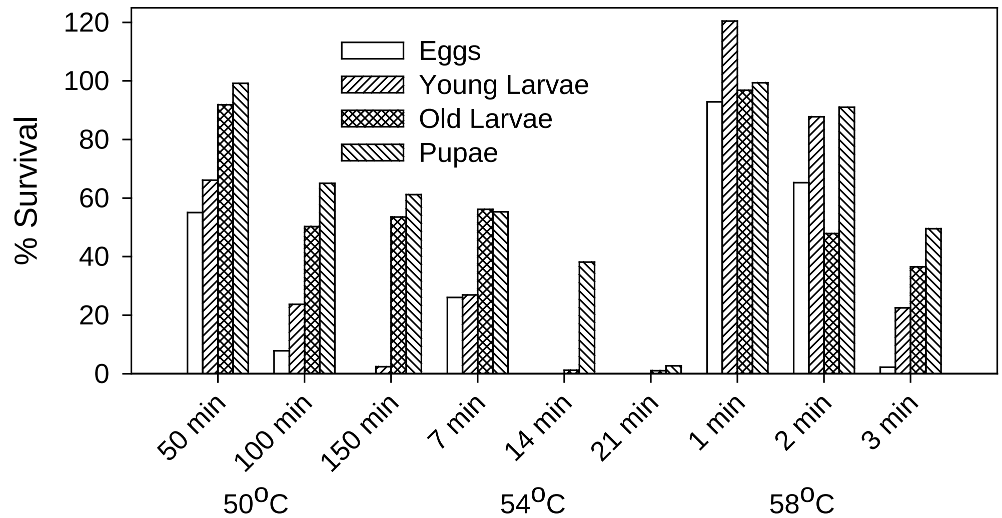

Figure 1. Survival of immature stages of cowpea weevil in mung beans after exposure to high temperatures; n ≈ 960 (≈ 320/rep) (survival determined by comparing adult emergence from treated beans with emergence from untreated beans)

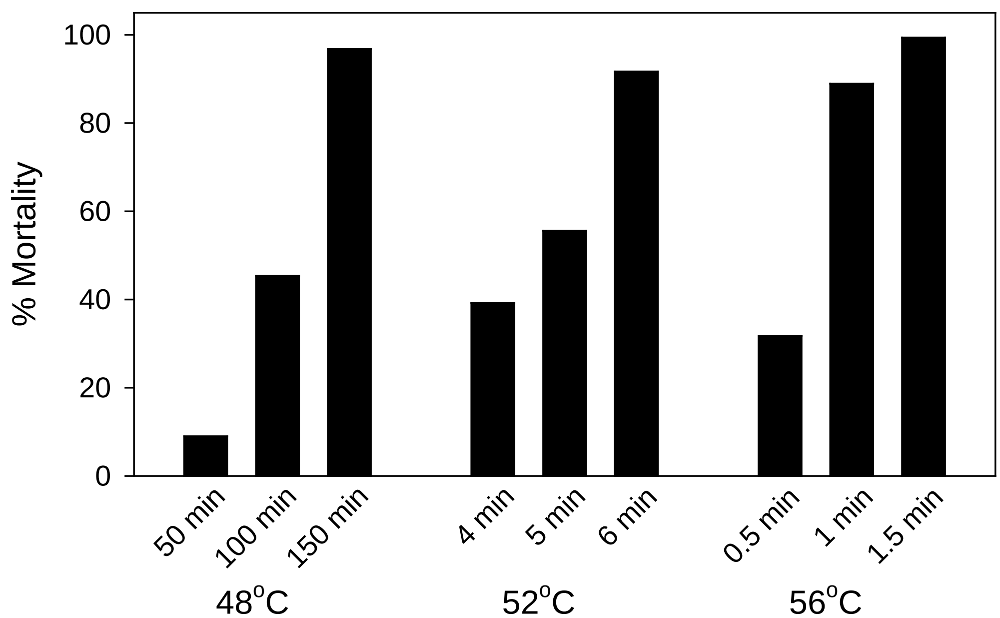

Figure 2. Response of adult cowpea weevils to high temperatures; n = 100 (complete mortality of adult weevils occurred at temperatures and exposures used for immature stages)

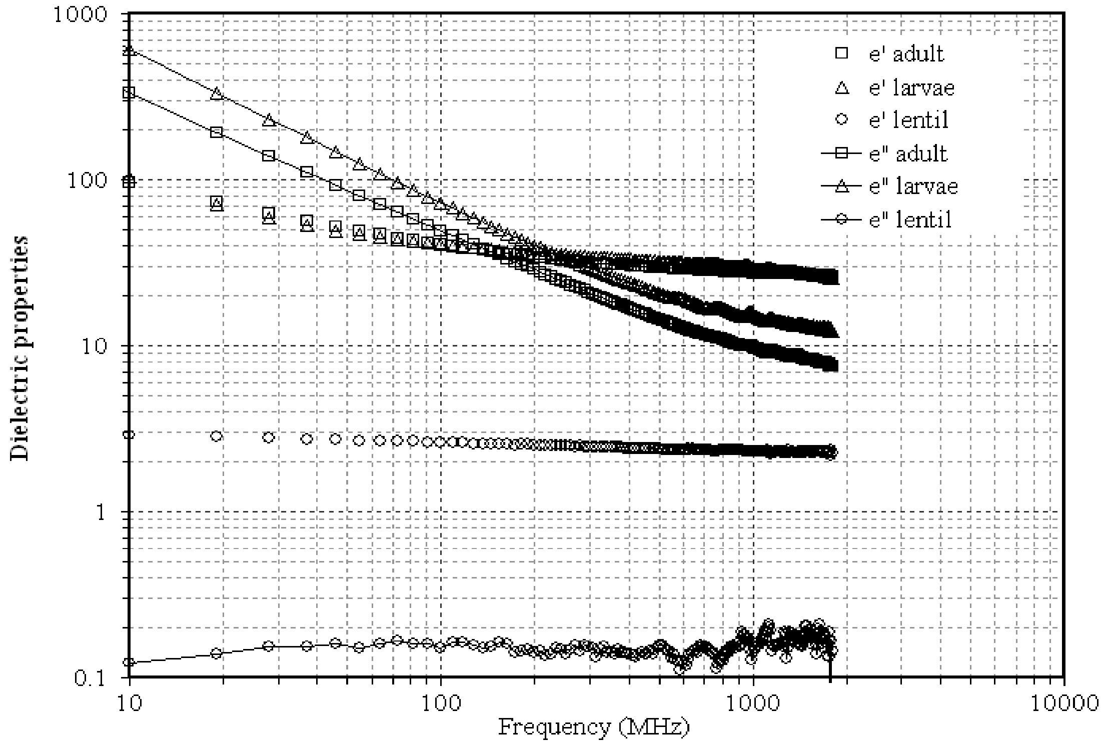

Figure 3. Dielectric constant (e') and loss factor (e") of cowpea weevil larvae and adults at 20°C as compare to those of lentil at moisture content of 8.4%.