HEATING STUDIES USING MICROWAVE ENERGY

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The use of microwave energy as a quarantine treatment for pests of food plants was reviewed by Hallman and Sharp (1994). Microwave energy is not used commercially to control pests primarily due to high energy costs, uneven heating of the treated product, and damage to the product, especially fresh fruits and vegetables. Nevertheless, a basic understanding of this technology and how it has been used as a research tool could be helpful in advancing the technology for quarantine use.

The microwave heating process was described for food products by Buffler (1993). Each food product has a characteristic microwave property, which along with geometry defines how it interacts with the microwave electric field within an oven cavity. Heating velocity depends on physical properties of the commodity such as size, shape, and thermal properties. Velocity of heating with microwave energy can be controlled depending on power, type of magnetron, and load and position of the commodity (Buffler 1993). Sharp (1994, 1996) exposed 5 different fruits and a vegetable to microwave energy to determine the heating sequence in each commodity having different shapes. Regardless of shape, heating occurred from the centers outward to the surface of each product at power settings up to 630 watts. Heating velocities increased as power to the load was increased. The result is consistent with the heating process described by Buffler (1993). A knowledge of which area of a product reaches a target temperature that is lethal for a specific pest or a particular stage of the pest, is critical information that researchers can use to control pests and to minimize damage to the market quality of the treated product.

Temperature-time mortality relationship studies have been conducted with eggs and larvae of different fruit fly species. Most research was completed using hot water immersion in controlled water baths (Jang 1986; Sharp and Chew 1987; Heard et al. 1992; Hansen and Sharp 1994). Only a few studies have evaluated temperature-time relationships using microwave energy (Hayes et al. 1984; Del Estal et al. 1986a, 1986b; Sharp et al. 1996). A temperature of 50°C kills all exposed larvae of fruit flies and has been documented using hot water immersion, vapor heat, and forced hot air studies. However, using microwave energy at powers greater than 11 watts, Caribbean fruit fly larval mortality was less than 100% when 50°C was reached in less than 11 minutes. In fact, as power to the larvae was increased from 11 to 122 watts, time to reach target temperature decreased and mortality was reduced. This finding is significant. Time of exposure required to reach a target temperature is critical in controlling stages of pests. Quarantine security could be jeopardized when heat treatments are applied too rapidly, such as the case when using microwave energy.

Microwave energy may be useful to control pests that are present in the seed of commodities such as mango and avocado. When microwave energy is applied to mango and avocado, heating occurs from the center to the surface (Sharp 1996). Perhaps temperatures lethal to the seed weevils can be reached within a time period so that the market quality of the treated fruits is not damaged.

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