MICROWAVE IRRADIATION OF FLOWING GRAIN TO CONTROL STORED-PRODUCT INSECTS

Thomas W. Phillips*[1], Steven L. Halverson [4,5], Timothy S. Bigelow[6], George N. Mbata, [1,], Patricia Ryas-Duarte[2] Mark Payton[3], William Halverson[2] and Stanley Forester[6]

[1]Dept. of Entomology and Plant Pathology, [2]Food and Ag. Products Center, and [3]Dept. of Statistics, Oklahoma State University, Stillwater, OK 74078
[4]Micro-Grain, Inc., 4242Wagner Dr., Clinton, WI 53525-9100, [5]Desceased
[6]Oak Ridge National Labs., Microwave Development Group, Oak Ridge, TN, 37831

Microwave radiation has the potential to kill insects by selectively heating the water of their tissues relative to a drier surrounding media such as durable stored grains and other similar dry commodities. Previous experiments by our group using microwaves at 28GHz determined mortality of three life stages of three species each of stored-product beetles to a range of power levels applied to insects in 200 g flowing wheat samples. The energy required to achieve 99% mortality of the most tolerant life stage (eggs of lesser grain borer or larvae of red flour beetles) was approximately 55 J/g with an upper 95% confidence interval of 75 J/g. Slight but significant effects of microwaves on grain quality were detected. However, values for percent germination (90-95%), flour yield (63%), percent protein (11.1%), dough mixing time (6-7 min), and bread baking quality (crumb texture of 9.8 and crumb grain of 9.5) were all within acceptable market values for grain treated at the highest microwave levels.

A validation experiment was recently conducted in which 15 kg samples of wheat were treated in a larger, flow-throw commercial prototype system at a flow rate approximately equivalent to 2 T/h. Two hundred late stage larvae of the red flour beetle were added to each grain sample. Approximately 25 sec was required for the 15 kg samples to pass through the applicator where microwaves were delivered. Microwaves at 28 GHz were applied at power levels of 20 and 26 kW in different treatments, and control samples were dropped through the applicator with no microwaves applied. Simply dropping grain through the applicator (7 m from delivery hopper to collection hopper below applicator) with no microwaves resulted in approximately 50% mortality of test larvae. No larvae survived successful treatments of the flowing grain at the 20 kW input power, and grain temperatures increased an average of 22.7 C. Severe arcing, resulting in inadequate microwave application, occurred during subsequent treatments, which were aborted. Arcing was likely due to excessive grain dust in the applicator and wave-guide; design modifications are needed to prevent this. Ancillary studies with static infested grain samples treated with 2.45 GHz at 30 kW killed 99+% of test insects and showed promise for use of this frequency in commodity disinfestations.