Title Disinfestation of stored grain insects using microwave energy

Author Vadivambal Rajagopal

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Abstract

Infestation of grain by insects is usually controlled using insecticides. Use of insecticides can result in chemical residues in the food which may have adverse effects on humans and animals. Disinfestation of grains using microwaves can be an alternate to chemical methods of killing insects in grain. A pilot-scale industrial microwave dryer operating at 2.45 GHz was used in this study to determine the mortality of different life stages of three common stored-grain insects namely *Tribolium castaneum* (Herbst), *Cryptolestes ferrugineus* (Stephens) and *Sitophilus granarius* (L.) in wheat, barley and rye. Grain samples of 50 g each at 14, 16, and 18% moisture content (wet basis) were infested with stored-grain insects. The samples were then exposed to microwave energy at four different power levels 200, 300, 400, and 500 W for two exposure times of 28 and 56 s. Complete (100%) mortality was achieved for adults of all three insect species at 500 W for an exposure time of 28 s and at 400 W for an exposure time of 56 s in barley and wheat. In rye, complete mortality of adult *T. castaneum* and *S. granarius* was achieved at 400 W, 28 s and at 300 W, 56 s whereas for *C. ferrugineus* , complete mortality was achieved at 500 W, 28 s and at 400 W, 56 s. The average temperature of wheat, barley, and rye at 500 W and 28 s was around 80, 71 and 82°C, respectively. Among the life stages of *T. castaneum* in wheat, eggs were the most susceptible followed by larvae, and the least susceptible were the pupae and adults. Among the life stages of *T. castaneum* in barley and rye, eggs were the most susceptible and adults were the least susceptible with no significant difference between pupae and larvae. There was no significant difference in the mortality of adult insect species at 14, 16, and 18% moisture content barley and rye and the life stages of *T. castaneum* and *S. granarius* in rye.

Germination tests were conducted for wheat, barley and rye and the germination of seeds decreased with an increase in power level or exposure time or both. The quality characteristics tested for barley were grain protein, alpha amylase, diastatic power, soluble protein, density and viscosity of the malt. The quality characteristics tested for rye were flour protein, flour yield, falling number, Sodium dodecyl sulphate sedimentation, dough mixing properties and loaf volume of the bread. The quality of the barley treated at 500 W for 28 s was the same as the control, whereas, there was significant decrease in the

quality of barley and barley malt when treated at 400 W for 56 s. There was no significant difference in the quality of microwave-treated rye except for a decrease in the flour yield. There was no significant difference in the quality characteristics of microwave-treated and control wheat.

The surface temperature distribution on barley, rye, oats, and sunflower seeds were determined with the microwave dryer and an infrared thermal camera. The thermal images showed that, there was a wide variation in the temperature distribution during microwave heating with hot and cold spots within a sample. The average temperature of the rye was the highest followed by barley, oats and sunflower seeds. The moisture loss corresponding to one hundred percent mortality in barley, rye and wheat at 500 Wand 28 s exposure time was 1.9, 2.5, and 2.0 percentage points, respectively.