Abstract

Insect infestation is an alarming concern in stored cereal grain, accounting for losses in quality as well as quantity. Major portion of the post-harvest losses can be saved by detecting the insects in early developmental stages and then disinfest the stored grains. Freshly harvested wheat was conditioned with moisture content of 12, 14, 18% (wb). The conditioned grains were artificially infested with *Sitophilus granarius* and *Rhyzopertha dominica* at a level of 0, 5, 10, and 15 number of insects per 100 g of grain and stored at 27 °C and 65% relative humidity for 180 days to produce various level of infestation. The samples were drawn at 45 days interval for analysis of physical and chemical properties, uric acid analysis. A total of 128 infested samples of each grain were also analyzed in FTNIR, E-nose, hyperspectral imaging and data library was created by considering both the responses from conventional analysis and from non-destructive methods. After insect detection, ozone fumigation and combined MW-UV treatment process were optimized for insect disinfestation in the stored wheat grains using response surface methodology.

FT-NIR spectral data were analyzed using partial least squares regression (PLS). The best model for properties with lowest RMSE values for moisture, protein, uric acid, 1000 kernel weight and hardness were 0.485, 0.248, 2.58, 0.576, and 0.762 respectively. R^2 obtained for the above said quality parameters were 0.901, 0.938, 0.895, 0.907 and 0.912 demonstrating good fit of the PLS models. E-nose responses were modelled using principal component analysis (PCA), which efficiently classified the most infested wheat grain samples among the stored samples. The fuzzy logic analysis suggested that T30/1, PA/2, P30/1, and P30/2 were the most reactive sensors to the volatile organic compounds generated due to infestation, which indicated presence of alcohol and ammonia. The E-nose sensor responses closely predicted the uric acid (R^2=0.958; RMSE= 1.401) and protein content (R^2=0.978; RMSE= 0.275). By using hyperspectral imaging, the reflectance spectra were analyzed using PCA to discriminate the uninfected kernels from infested ones. The R^2 and RMSE values of the developed ANN models were 0.999, 0.968 and 0.910 for number of insects, protein and uric acid content respectively. It was observed that E-nose was proven to be an efficient technique for detection of insect infestation in stored wheat. Alcohol and ammonia sensors were integrated with a microcontroller unit to fabricate the sensor, which was effective enough to detect the level of infestation based on

the headspace gas composition. The optimized condition for ozone fumigation in stored wheat grain were found to be moisture content of 12.08% (wb), 2.44 g/m^3 ozone concentration and 7.79 h of exposure time for mortality of 98.99%, 101.94%, 100.46%, and 102.93% adults respectively. The optimized combined MW-UV treatment process were moisture content of 13.73% (wb), 600 W microwave power level, and 106.18 s of exposure time for mortality of 99.34%, 98.30%, 97.63% adults, larvae and eggs respectively. The final moisture content at optimized treatment condition was found to be 10% (wb). The outcome of the project leads to use of a convenient, rapid yet nondestructive approach for quality determination of insect infested wheat grains at various stages during the storage. Also, an effective disinfestation process for disinfestation of adult insects as well as the immature stages was optimized.

Keywords: Infestation; FTNIR; E-nose; Hyperspectral imaging; Ozone, Microwave-UV