Optical Detection of Microbial Contamination in Food Matrices

Securing Our Food Supply

Threat agents in low dosages can be effective in contaminating food supplies. Therefore, agent detection systems need to have high sensitivity. They must also be able to identify a specific signal from the chemical/biological agent while rejecting, or at best, minimizing any signal originating from a nonpathogenic or nontoxic biological background.

The U.S. Centers for Disease Control and Prevention (CDC) has developed a strategic plan for dealing with biological and chemical terrorism. The CDC plan identifies and ranks several food borne pathogens as critical agents for possible terrorist attacks. Notably, several of the pathogens identified by CDC as critical biological agents also have been linked to significant outbreaks of food borne illness due to unintentional contamination.

Detecting Food Borne Pathogens

Researchers at the University of Kentucky and the Quality & Safety Assessment Research Unit, USDA Agricultural Research Service (ARS), Athens, GA) conducted research on the potential for real-time detection, identification, and quantification of microorganisms in food matrices. ARS collected background optical information on pure cultures of pathogens in plates and solutions, and this information was used to determine the identifiable detection levels of pathogens in food matrices. UK developed a microbial separation technique to separate microorganisms from the food solids in matrices to enhance the opportunity for optical identification. Hyperspectral imaging techniques were tested for detecting pathogens in solutions.

In this project, five optical detection systems were evaluated for detection of foodborne pathogens. They are: Visible Near Infrared (VNIR) Hyperspectral Imaging System; Visible Near Infrared (VNIR) Hyperspectral Microscope Imaging System (HMI); Short-Wave Near Infrared (SWIR) Hyperspectral Imaging System; Fourier-transform infrared (FTIR); and Surface Enhance Raman Spectroscopy (SERS). Each system had both strengths and weaknesses when compared to the other systems. Early in the assessment of the systems, the Short-Wave Near Infrared (SWIR) hyperspectral imaging system was determined to be unsuitable for further evaluation. The VNIR and SWIR systems were easier to use (relatively) than the HMI, FTIR, and SERS systems. In these studies for specificity, the VNIR system was able to provide the highest classifications of bacteria, while the HMI, FTIR, and SERS systems provided good classification rates. For imaging foodborne pathogens of moderate sample size, the VNIR and SWIR systems were faster in data acquisition than the others yet none of them were considered very fast. In summary, the VNIR system had the best feasibility for implementation and had the best commercial potential of the five systems. A full report of this work is available.

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