Multistate Research Project S-294
Postharvest Quality and Safety in Fresh-cut Vegetables and Fruits

2007-2008 Activities Report

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Introduction:
The USDA Food Safety Laboratory (FSL) is charged with developing methods to reduce risks associated with foodborne pathogens on produce. The primary goals are to identify and sequester produce contaminated with fecal material in real time, and to develop instruments to allow commodities and food processing areas to be surveyed for contamination and cleanliness issues. Quality issues are also important as defect sites on produce can foster growth of pathogenic organisms. Detection methods are generally based on imaging spectroscopy and efforts are broken down into three areas based-on target size: microscopic detection, small area detection, and detection on processing lines. Lab personnel are responsible for developing the theoretical basis for new detection methods and for using these methods to build commercial prototype systems. In this regard, the FSL is also responsible for developing or modifying existing technology to allow the detection methods generated in-house to be applied in a commercial setting. An example of this is the development of an inexpensive method to orient apples so that a camera can see inside the concave stem and calyx regions. In the last year of this project, six peer reviewed manuscripts have been published, two patent applications for detection methods have been filed, and three CRADAs have been initiated. Currently, the laboratory is looking for industrial partners for the patent pending technologies of orienting apples based on their inertial properties and for a hyperspectral/multispectral linescan imaging system that can simultaneously acquire reflectance and fluorescence images using a single camera.

Activities
Objective 1. Develop, evaluate, and standardize subjective and objective quality evaluation methods in intact and fresh-cut fruits and vegetables.
see Objective 5

Objective 5. Evaluate and control unintentional and intentional microbial contamination of intact and fresh-cut produce.

- PROJECT: Develop Spectroscopy Techniques for Detection of Trace Bacteria and Biological Toxins in Foods. Efforts continue to develop a Surface Enhanced Raman Spectroscopic (SERS) method as a rapid and routine detection technique, and to fabricate and characterize SERS nano-probes to provide localized and non-destructive SERS identification on surfaces of bulk samples. During the last year a rapid method to detect melamine in food stuffs used to create animal meals was developed and a CRADA was signed with ChemImage for development of a commercial instrument and for future collaboration on imaging technologies.
- PROJECT: Development of Technology for Surface Sensing of Food Pathogens. Efforts continue in development of sensing technologies for detection of evidence of bacterial and

bioagent contamination on food surfaces. Primary targets of interest are produce and food preparation areas. Work continues with CRADA partner AHPharma to develop a handheld device to survey food processing areas.

- PROJECT: Development of New and Improved Systems to Enhance Food Safety Inspection and Sanitation of Food Processing. This is the primary project in the laboratory and the two projects above were spun-off from this project. During the last year, most work on this projected centered on developing technologies to allow apples to be screened and sorted for evidence of fecal contamination. Work continued on the orientation track system. It was previously found that when apples are rolled down a track consisting of two parallel rails, the apples move to an oriented position where the stem/calyx axis is perpendicular to the direction of travel and parallel to the plane of the track. In addition to the ability to orient apples, it is envisioned that the track system can be used to transport apples during processing, thus replacing the more costly conveyor systems currently in use. Work also continued on developing imaging systems and detection algorithms to simultaneously identify quality problems and contamination of apples during processing. In this regard, a utility patent application was submitted for a hyperspectral/multispectral line scan imaging system that can be used to simultaneous acquire reflectance and fluorescence images using a single EMCCD camera. Tests of this imaging system using a cup-based conveyor system demonstrated that both defective and contaminated apples could be identified with near 100% accuracy.

Publications:

Current only for 2007-2008 (peer reviewed)

Kim, M.S., Chen, Y.R., Cho, B., Chao, K., Lefcourt, A.M., Chan, D.E. 2007. Hyperspectral reflectance and fluorescence line-scan imaging for online quality and safety inspection of apples. Sensing and Instrumentation for Food Quality and Safety 1(3):151-159.

Liu, Y., Chen, Y.R., Kim, M.S., Chan, D.E., Lefcourt, A. M. 2007. Development of simple algorithms for the detection of fecal contaminants on apples from visible/near infrared hyperspectral reflectance imaging. J Food Eng 81:412-418.

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Kim, M.S., Cho, B., Lefcourt, A.M., Chen, Y.R., Kang, S. 2008. Multispectral fluorescence lifetime imaging of animal feces contaminated apples by time-resolved laser induced fluorescence imaging system with tunable excitation wavelengths. Applied Optics 47(9), in press.

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