SAFEGUARDING THE FOOD SUPPLY

A growing world population, increasing environmental challenges, changing consumer preferences, and the impact of small-scale farming on nutrition and human health have resulted in the need to study the food supply as an integrated system. The ARS food safety research program ensures a safe food supply that meets foreign and domestic regulatory requirements. Emerging research areas focus on metagenomics, climate change and mycotoxin contamination, food adulteration and fraud, reduction of foodborne pathogens during animal and produce production and food processing, and contamination of ready-to-eat foods. The following accomplishments highlight ARS advances in food safety research in 2021.

In-package pulsed light treatment for increasing produce safety. Post-processing contamination with pathogens such as Escherichia coli O157:H7 is a major contributing factor to foodborne illness outbreaks, and safe and effective methods are needed to minimize contamination. ARS researchers in Wyndmoor, Pennsylvania, developed an in-package high-intensity pulsed light treatment capable of penetrating plastic film and killing E. coli O157:H7 on the surface of Romaine lettuce inside sealed packages. The treatment also reduced native microbial populations by greater than 90 percent, irrespective of the thickness of the plastic wrapping. Pulsed light treatment is an alternative green, chemical-free, nonthermal, post-packaging intervention treatment for leafy greens and other fresh and fresh-cut fruits and vegetables.

Semicarbazide during poultry processing. To ensure food is safe from chemical contaminants, detection technologies should be accurate and reliable. Semicarbazide (SEM) is an indicator compound used by national and international organizations to infer the use of nitrofurazone, a banned antibiotic, in animal production. Recently, the detection of SEM by a significant importer of U.S. poultry resulted in an import ban for products from specific processing plants. The validity of using SEM as an indicator for nitrofurazone has been questioned in recent years. Strong evidence has emerged that sanitizers used in processing facilities to decontaminate meat may chemically create SEM from biological molecules in the complete absence of nitrofurazone use. ARS researchers in Athens, Georgia, conducted studies indicating that this unintentional production of SEM on poultry meat was creating false positives for the presence of nitrofurazone. An extensive survey of poultry processing plants indicated that the use of certain antiseptic chemicals, in combination with pH, can react with meat tissue to produce detectable levels of SEM. These data confirm that incidental production of the chemical can occur in processing facilities; therefore, SEM is not a reliable indicator of nitrofurazone, and alternative indicators of nitrofurazone use should be developed. This data has been transferred to food safety regulatory agencies, industry, and trade organizations to ensure and avoid inaccurate contamination reports, and to eliminate economic loss and potential trade issues.

> **Aflatoxins are carcinogenic fungal toxins produced by Aspergillus supp. that cause serious animal and human health issues. ARS researchers in Maricopa, Arizona utilized DNA-based markers to genotype nearly 29,000 isolates originating from 35 countries in North America, Central America, Africa, Europe, Asia, and Australia. Based upon these analyses, an online database called "AflaSat" was developed, and standardized genotype data for each isolate was uploaded and made accessible to international collaborators.**

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Deep learning approach for classifying contamination levels. Mercury (Hg) and arsenic (As) ions have been recognized as chemical threats to human health and can be present in foods in trace amounts. A critical issue recognized by the U.S. Food and Drug Administration and other organizations is the difficulty detecting low contamination levels in the parts per billion range. This remains challenging due to the small number of available data samples and significant intra-class variance. ARS researchers and colleagues at Purdue University's Center for Food Safety Engineering explored techniques for synthesizing realistic colorimetric images and proposed a Convolutional Neural Network (CNN) classifier. The system was trained and evaluated on a dataset of 126 images captured with a cell phone camera representing 5 contamination levels. The system accurately classified 88.1 percent of the contaminated images and classified contamination levels with a precision level of 91.9 percent. Using this system would allow regulators, processers, and consumers to use cell phone cameras to capture images that can estimate heavy metal contamination levels and advance the protection of the food supply.

Shelf life and season are drivers of Escherichia coli O157:H7 survival on cut lettuce. *Escherichia coli* O157:H7 infections from contaminated lettuce continue to impact public health and the U.S. lettuce industry, which is valued annually at nearly $2 billion. Outbreaks linked to products grown in California occur predominantly from fall-harvested lettuce, and the reason for this seasonality is unknown. ARS researchers in Albany, California, and partners at the U.S. Food and Drug Administration Center for Food Safety and Nutrition identified the fall season and lettuce cultivars with poor shelf life as the main drivers of *E. coli* O157:H7 survival and microbiome structure. These results open new fields for inquiry into the seasonal aspects of the physiology of fresh-cut lettuce and its microbiome that may prevent the seasonal occurrence of *E. coli* O157:H7 infections. Likewise, the identification of shelf life as an important lettuce trait in *E. coli* O157:H7 survival suggests that genetic breeding for improved lettuce shelf life could be an integral part of a successful strategy to enhance produce safety.

Cheung, Lance (with permission of Five Sandoval and Pueblo of Isleta.) Roy and Santana Townsend of San Felipe Pueblo, NM have checked in with the Five Sandoval Indian Pueblos, Inc. (Five Sandoval) food distribution center in Bernalillo, NM, on September 10, 2019. USDA Photo. https://flic.kr/p/2i1dVGS