Agricultural Research Service
National Program 108:
Food Safety 2006 Annual Report

Agricultural Research Service
U.S. Department of Agriculture
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Executive Summary

Food Safety falls under Goal 4 of the Agency Strategic Plan**: Enhance Protection and Safety of the Nation's Agriculture and Food Supply**. For the Nation to have affordable and safe food, the food system must be protected at each step from production to consumption. The production and distribution system for food in the United States has been a diverse, extensive, and easily accessible system. This open system is vulnerable to introduction of pathogens and toxins through natural processes and global commerce and by intentional means. In response to these threats, crop and livestock production systems must be protected from the ravages of diseases whether domestic or exotic in origin. The food supply must be protected during production, processing, and preparation from pathogens, toxins, and chemical contamination that cause disease in humans.

Food safety research seeks ways to assess and control potentially harmful food contaminants. Research to ensure a secure agricultural production system refers to work that reduces or eliminates factors that threaten the ability of U.S. agriculture to produce enough food and fiber, year to year, to meet the needs of American consumers. ARS will conduct research designed to generate knowledge regarding new and improved management practices, pest management strategies, sustainable production systems, and control of potential contaminants for farms of all sizes. These activities will ensure a secure production system able to provide a safe, plentiful, diverse, and affordable supply of food, fiber, and other agricultural products. ARS will provide scientific information and technology to producers, manufacturers, regulatory agencies, and consumers to support their efforts to provide a secure, affordable, and safe supply of food, fiber, and industrial products.

The Programs mission is to provide through scientific research, the means to ensure that the food supply is safe and secure for consumers and that food and feed meet foreign and domestic regulatory requirements. Food safety research seeks ways to assess, control or eliminate potentially harmful food contaminants, including both introduced and naturally occurring pathogenic bacteria, viruses and parasites, toxins and non-biological-based chemical contaminants, mycotoxins and plant toxins. Since food safety and food security are global issues, our research program involves both national and international collaborations through formal and informal partnerships. Our accomplishments and outcomes are utilized in national and international strategies delivering research results to regulatory agencies, commodity organizations and consumers.

The Programs vision is for the Nation to have a safe, plentiful, diverse, affordable, quality food supply, protected during production, processing, and preparation from pathogens, toxins, and chemical contamination that cause disease in humans.

The research components of this Program include:

- [Microbial] Pathogens, Toxins and [non-biological-based] Chemical Contaminants: subdivided in Pre-harvest and Post-harvest.
- Mycotoxins and Plant Toxins

Selected Research Highlights

Detection and fingerprinting of *E. coli* O157:H7 in California agricultural environments. Numerous outbreaks of *E. coli* O157:H7 have been linked to produce grown and processed in California. Knowledge of the epidemiology and ecology of *E. coli* O157:H7 in this agricultural environment is critical for preventing contamination of raw produce in the fields. ARS scientists in Albany, California, in collaboration with the California Department of Health Services, Central Coast Regional Water Quality Control Board, and FDA, sampled numerous watershed sites in Salinas Valley, California. Multiple *E. coli* O157:H7 strains, sources of dissemination, and persistence related to the watershed were identified. This information was critical to the industry and regulatory agencies in their analysis of the recent spinach related *E. coli* O157:H7 foodborne illness outbreak.

Preharvest strategies devised to kill Salmonella, Campylobacter, and *E. coli* O157:H7. Foodborne pathogens can live in the gastrointestinal tract of food animals. Researchers from College Station, Texas, and Athens, Georgia, have devised diverse strategies to reduce pathogenic bacteria in food animals during the production chain. An antimicrobial protein was discovered that reduces Salmonella infections in egg-laying chickens by stimulating the birds' own immune system. As a feed additive, this protein shows great promise in reducing Salmonella in poultry and is being subjected to further real world testing. Other researchers have shown that the addition of a bacterial protein (called a bacteriocin) can reduce Campylobacter populations in chickens. In cattle and swine, the pharmaceutical product Ractopamine that is used to promote growth and increase lean muscle mass was found to reduce *E. coli* O157:H7 intestinal colonization and fecal shedding in feedlot cattle. All of these pathogen reduction strategies are important because they do not use traditional antibiotics, which increase antibiotic resistance.

Handheld imaging devices. Scientists at Beltsville, Maryland, designed two handheld portable inspection devices equipped with head mount displays and wireless image-voice central communication capabilities for sanitary inspections of food processing plants. The technology has applications for the inspection of foods and processing plant sanitation, such as for fecal contamination on stainless steel plates that are typically used for manufacturing plant equipment. Various food safety regulatory agencies, security agencies, and commodity organizations have shown considerable interest in the technology. A U.S. patent application for the technology has been submitted.

Detection of E. coli O157:H7 and Salmonella. In order to quantify the risks associated with the slaughter of animals that may harbor or shed E. coli O157:H7 or Salmonella species, accurate estimates of the prevalence and frequency of pathogen distribution and relative concentration on hides and in feces is needed. ARS scientists at the Clay Center, Nebraska, developed two methods for the direct enumeration of E. coli O157:H7 and Salmonella species. Use of the methods for pathogen enumeration data, in combination with pathogen prevalence, will provide processors and regulatory agencies with greater control of potential pathogen contamination and further improve the safety of beef for consumers.

Live or dead bacteria. There is a need to differentiate between live and dead bacteria in foods. Scientists at Wyndmoor, Pennsylvania, in collaboration with Purdue University, have developed a test using specialized spectroscopy methods to readily differentiate live versus dead cells of E. coli O157:H7. This test permits rapid differentiation for cells killed by the various processing techniques used in industry. Because of the relative speed of this multi-step procedure, large numbers of cells could be quantitatively analyzed. Regulatory agencies will greatly benefit from the implementation of this technology.

Flies and transport trays can spread Salmonella and Campylobacter in poultry. Campylobacter and Salmonella are the two most common food-borne pathogenic bacteria affecting the U.S. and are both associated with poultry; they cost the U.S. economy approximately $4 billion per year in direct and indirect costs. Scientists in Athens, Georgia, and Gainesville, Florida, found that flies could transmit Salmonella through direct surface contact or being eaten by hens. Researchers found that flies could spread Salmonella between rooms and houses that have been decontaminated. Other scientists in College Station, Texas, found that the tray liners used to transport newly hatched chicks from commercial hatcheries could contain Campylobacter, thus serving as a vector to the newly hatched bird. Combined, the results of these research projects suggest two new critical control points where we can attack the spread of Salmonella and Campylobacter on the farm.

Soil cadmium can be concentrated in lettuce. Some trace elements such as cadmium, lead, and arsenic can be transferred to crops when they are grown on mineralized or contaminated soil. International sales of some foods, such as sunflower kernels, flax, durum wheat, and Romaine lettuce, have been limited by high natural crop cadmium levels. Researchers in Beltsville, Maryland, characterized cadmium accumulation in lettuce and spinach grown in specific soil types (Lockwood and marine shale parent rocks) and found that lettuce from these studies would violate international limits for leafy vegetables if such limits were established. These studies demonstrate the need for technologies that can phytoextract cadmium from soils or can reduce cadmium uptake and accumulation in lettuce and spinach.

Radiation inactivation of furan and acrylamide in foods. Furan and acrylamide are chemicals of concern found in many thermally processed foods. Scientists at Wyndmoor, Pennsylvania, conducted studies to determine if ionizing radiation could decrease the amount of furan and acrylamide in various foods. Low dose ionizing radiation significantly reduced furan levels in ready-to-eat meats, but had a limited effect on the inactivation of acrylamide in oils and potato chips. This data will directly assist the Food and Drug Administration in evaluating a petition currently under review to allow irradiation of ready-to-eat foods.

Norwalk virus detection. Norwalk virus cannot be cultured, and therefore detection relies on capture and concentration of the virus. Scientists at Albany, California, developed a novel Polymerase Chain Reaction (PCR) method involving an immunochemical capture step and real-time PCR (rtI-PCR). The sensitivity of this rtl PCR technology is significantly increased over the standard ELISA and traditional reverse transcriptase (RT) PCR for the detection of virus in stool and food samples. Public health agencies have a critical need for simpler, faster, and more sensitive detection methods for this common viral food contaminant.

Mycotoxin detection methods developed to make toxin identification easier. There is a wide variety of mycotoxins that are structurally different and have different modes of action. The differences in toxin structure makes identification of the specific toxin involved in illnesses or crop death difficult and time consuming. Researchers in Peoria, Illinois, have synthesized and characterized molecularly imprinted polymers that bind the mycotoxin moniliformin. The synthesis of the imprinted polymers will allow for rapid diagnostics and for evaluation of strategies to bind toxins in feeds, foods, and humans. Other researchers at Peoria have produced monoclonal antibodies that recognize the mycotoxins nivalenol and vomitoxin. These antibodies can be used simultaneously to screen corn, wheat, and barley for these important toxins through a simple ELISA test, and prevent them from affecting humans, animals, or plants.

Petting zoo livestock not burdened with pathogenic bacteria. Salmonella, *E. coli* O157:H7, and related bacteria are some of the most critical food safety issues because of the severity of illness they cause in children and the elderly. Petting zoos are designed to expose children to animals, including livestock, but in several cases they have exposed children to pathogenic bacteria. Clay Center, Nebraska, researchers surveyed more than 1,000 animals in 25 States and demonstrated that the prevalence of these pathogens in petting zoo livestock with human-animal contact was less than 0.6 percent. This is contrasted with the 20-fold higher incidence in commercially reared livestock or livestock displayed at agricultural fairs. The results indicate that preharvest control of pathogenic bacteria is indeed possible.

Antioxidants reduce aflatoxin concentrations in tree nuts. Tree nuts sales are estimated at $2 billion per year; approximately 60 to 70 percent of the crop is exported. Aflatoxin is a serious threat to human health and agricultural trade because it is a potent natural carcinogen produced by a fungus. Levels of aflatoxin in tree nuts are closely monitored by importing nations. Research in Albany, California, has demonstrated that some antioxidants reduce fungal synthesis of aflatoxin by enhancing the natural breakdown of aflatoxin by the fungus that produces it. Antioxidant levels can be increased through selective breeding or direct application to tree nuts, making them safer for consumers and more acceptable to trading partners.