Southwest Agricultural Region Environmental Microbiology Study (2019 – 2024)

<< Environmental Studies Main Page (/food/microbiology-research-food/environmental-studies)

In 2019, the FDA, in collaboration with the University of Arizona, the Wellton-Mohawk Irrigation and Drainage District, local growers, industry groups, and others, began a multi-year study in Yuma County, Arizona – which grows many of the leafy greens sold in the United States. The study was designed to improve understanding of the environmental factors that may impact the presence of foodborne pathogens in the Southwest agricultural region. The research team was particularly interested in identifying new information about factors that significantly contribute to the introduction, persistence, growth, spread, and die-off of pathogens that could contaminate produce prior to harvest in this region.

The study involved collecting environmental samples throughout a five-year period. Samples were collected from irrigation waters, soil, sediments, air/dust, animal fecal material, wildlife scat, and other sources across approximately a 54 mile (7,000 acres) area of the southwest growing region, which also represents about 12% of the Wellton-Mohawk Irrigation and Drainage District's agricultural production area. Water sampling occurred from the headworks of the Wellton-Mohawk canal and at multiple points as the canal splits and flows thru the Gila Valley and Texas Hill area. Other select surface water sites were also sampled. Special attention was given to the geography of the study region and the types and locations of agricultural and other adjacent and nearby land use activities (/food/food-safety-modernization-act-fsma/adjacent-and-nearby-land-use-and-its-impact-produce-safety) relative to produce production areas. For example, there is a Concentrated Animal Feeding Operation (CAFO) with more than 80,000 head of cattle and an associated compost operation in proximity to some of the produce production areas studied. In addition, research plots of romaine lettuce were grown within the study area over several seasons to capture data on pathogen prevalence and persistence as well as to evaluate the influence of specific growing and harvesting practices. Pertinent meteorological information (air temperature, wind speed and direction, rainfall, etc.) was also logged.

Collected samples were analyzed using microbial culture methods, metagenomics, and whole genome sequencing to identify pathogens and microorganisms that can be indicators of unhygienic conditions. Through repeated sample collection, testing, measurement, and analysis,

we observed fluctuations in the types and prevalence of pathogens and indicator organisms over time and location, including variability across different seasons.

The findings of this study contribute to a better understanding of the impact various environmental factors can have on food safety and may be used to refine best practices for growers to continually improve produce safety.

Key Findings

The research team conducted over 100 sampling events at 55 sites resulting in more than 5,000 unique samples collected and 15,000 individual tests for detection of generic *E. coli*, *Salmonella*, and Shiga toxin-producing *E. coli* (STEC), including *E. coli* O157:H7. The research team then performed whole genome sequencing and analyzed isolated strains to determine their genetic relatedness as well as distribution across the study region. The research scientists are continuing to analyze data from this study, however preliminary key findings include:

- **Airborne Pathogens:** Airborne transmission of viable STEC was documented on numerous occasions at several locations adjacent to and at incremental distances from a nearby large livestock and composting operation (80,000+ cattle). In addition, air, water, and lettuce leaf microbiome analysis demonstrated deposition of dust from cattle pens to the nearby water and land, suggesting that dust from CAFOs may play a role in STEC transmission in this part of the region. These findings indicate that STEC can survive in the air and that dust can act as a transfer mechanism for both pathogens and indicator organisms (e.g. generic *E. coli*) from adjacent and nearby land to water, soil, and plant tissue. Additionally, distance played an important factor in the likelihood of STEC being detected in collected airborne dust, with percentage of positive samples declining steadily as air sampling moved in an incremental manner away from concentrated animal operations.
- **Water Quality:** The research team repeatedly observed that generic *E. coli* concentrations and STEC prevalence and isolation frequency increased as irrigation canal water flowed past an adjacent livestock and compost operation. In addition, these changes in water quality occurred absent other explanations such as surface run-off or other direct contamination, which indicates that airborne disposition of dust from a nearby CAFO was potentially a factor in the contamination of the irrigation water. Similar findings were not observed from samples obtained concurrently from a different nearby irrigation canal that flows south of the CAFO and associated compost operation suggesting the important role of localized southerly winds in transferring CAFO-associated dust in northward directions.

- **Wildlife Contributions:** Over 1,000 samples of wildlife fecal material, including from a wide variety of mammals and birds, were collected to study the role wildlife in this region may contribute to pathogen dissemination. A special emphasis was placed on birds, both native and migratory, given their presence and ability to access both terrestrial areas including produce fields and livestock areas, and various surface water locations including irrigation canals. In total, over 40 different bird species were sampled, with red-winged black birds being the only species testing positive for STEC in very few of the nearly 60 samples collected from this bird species. Therefore, birds and other wildlife do not appear to be significant sources of STEC or *E. coli* O157:H7 in or around the part of the Southwest growing region evaluated. However, continued monitoring is warranted to reduce potential risk to produce, the environment and water sources.
- **Whole genome sequencing results:** More than 40 different STEC serotypes were recovered from roughly 500 different samples representing all the matrices examined in this study. STEC strains detected in water, sediment, and plant tissue harvested from our research plots genetically matched strains isolated in air samples providing evidence that bacteria in air can transfer to other locations and surfaces.

The research team is continuing to analyze data from the study. For instance, meteorological data were collected at the time of sampling and are being used to evaluate whether factors such as wind speed and direction are drivers for both the positive and negative results obtained. As more information and findings become available this page will be updated.

Post-Study Actions

The preliminary results of this study stress the interconnectedness between people, animals and the environment and serve as an important model for how to foster productive dialogue among diverse stakeholders to improve food safety. Just as collaboration across the Southwest agricultural community was key to the development and execution of this study, continued collaboration among stakeholders including livestock managers/producers, fresh produce growers, academia, extension, retailers, and federal, state, and local government partners will be important to help control and mitigate potential contamination via environmental transmission including air/dust from adjacent and nearby land.

Members of the Arizona leafy greens industry will be working through the Desert Food Safety Coalition to continue to collaborate with the Arizona Department of Agriculture, University of Arizona Extension, Yuma Fresh Vegetable Association, Yuma Safe Produce Council, Arizona Farm Bureau, Arizona Leafy Green Marketing Agreement (AZ LGMA), Western Growers,

USDA-APHIS Wildlife Services, Arizona Cattle Feeders' Association, additional grower and landowner coalition members and other agricultural community stakeholders to engage the industry and inform best practices to improve food safety in the region.

While the results are regionally specific, the findings may also help us to address some knowledge gaps identified in the Leafy Green STEC Action Plan (/food/foodborne-pathogens/leafy-greens-stec-action-plan), particularly concerning adjacent and nearby land use (/food/food-safety-modernization-act-fsma/adjacent-and-nearby-land-use-and-its-impact-produce-safety). As additional data analysis is completed, FDA plans to engage with stakeholders to further explore the data and information gathered from this study.

The research team intends to present additional details about this study during the International Association for Food Protection annual meeting July 14-17, 2024. As final data analysis occur, we intend to publish manuscripts on this in the scientific literature. Additional information and publications will be added to this page as they become available.

Study Collaborators

The FDA would like to acknowledge and thank the collaborators that contributed to this study.

- FDA
- Arizona Department of Agriculture
- Arizona Game & Fish Department
- The Desert Food Safety Coalition
- The University of Arizona, Department of Environmental Science
- The University of Arizona, Maricopa Agricultural Center
- The University of Arizona, Yuma Agricultural Center
- USDA APHIS Wildlife Services
- Wellton-Mohawk Irrigation and Drainage District
- Yuma Fresh Vegetable Association
- Yuma Safe Produce Council
- Arizona Leafy Green Marketing Agreement
- Local growers and industry members

Study Related Announcements

- FDA Partners with the University of Arizona, Wellton-Mohawk Irrigation and Drainage District, and Yuma Area Leafy Greens Stakeholders to Enhance Food Safety (/food/hfp-constituent-updates/fda-partners-university-arizona-wellton-mohawk-irrigation-and-drainage-district-and-yuma-area-leafy)