

CPS Research Symposium 2016



Sheraton Seattle Hotel
Seattle, Washington
June 28-29



CPS CENTER *for* PRODUCE SAFETY

www.centerforproducesafety.org

Welcome

Dear Friends,

It is a signal honor to host the Center for Produce Safety's annual symposium in Seattle. We welcome all the food safety research scientists, produce industry leaders, government officials, and others who are attending this important gathering. I know all participants will engage and learn, and enjoy our Emerald City.



Sincerely,

Christian Schlect
President
Northwest Horticultural Council

On behalf of the members of the Center for Produce Safety, I'd like to welcome you all to the 2016 Research Symposium. We are pleased to enjoy a very high level of interest from attendees, which we attribute to the talented scientists and esteemed moderators and panelists being featured this year. We are so grateful they have decided to dedicate so much time to creating an informative and compelling symposium. I also want to thank our generous sponsors for their support in helping us with our mission to enhance produce safety for everyone.



Sincerely,

Bonnie Fernandez-Fenaroli
Executive Director
Center for Produce Safety

About Center for Produce Safety (CPS)

CPS, a non-profit foundation, is focused exclusively on providing the produce industry and government with open access to science-based information needed to continually enhance produce safety. Since it was founded in 2007, the Center for Produce Safety has provided over \$20 million to fund produce-specific safety research. The Campaign for Produce Safety aims to expand this vital work to close knowledge gaps with science-based research that enhances produce safety in the United States and worldwide. Ongoing administrative costs are covered by the Produce Marketing Association, enabling industry and public funds to go exclusively to research.

Chairman's Welcome

Welcome to the seventh annual Center for Produce Safety Research Symposium, and to beautiful Seattle. It is fitting that we convene this year in such an important U.S. fruit and vegetable producing state, for such important conversations.

The fresh produce industry supply and demand chain gathers together here because while we are part of an incredible dynamic of creating food for the world, at the same time we are also consumers. We want to produce healthy, nutritious, safe food for ourselves, for our children and our grandchildren. That is also who the CPS is, and why the center exists. Because CPS is a public-private partnership between industry, government and academia, the center is uniquely positioned to foster the open and honest discussions we will have over the next two days. Since being formed in 2007, CPS has awarded over \$20 million to fund 123 research projects – each and every one specific to our industry, science-based and actionable in our everyday activities from field to fork.

It is because of CPS's unique mission that it has been able to achieve so much at such a young age. Thanks to all of our volunteer leaders and to the success of our Campaign for Produce Safety, this year's symposium is our coming out party. The Center for Produce Safety has exploded into ADULTHOOD!

The Campaign for Produce Safety was designed to ensure that CPS has the funding to continue into that adulthood. The campaign has been very successful so far, the speed of its success being a reflection of the speed of the business of produce. Private money campaign supporters range from avocados to zucchini, small growers to large food conglomerates.

We thank you all for your generosity. And we aren't finished! The campaign committee is working hard to fuel the generosity of our industry donors and volunteers with matching funds from the public sector.

It takes a village to make CPS's work happen. Dozens of volunteer leaders invest countless hours serving on the Board of Directors and Technical Committee, and an army of reviewers tirelessly vet every research proposal we receive. This event wouldn't be possible without the moderators, panelists and scientists who will bring the research findings to life. Thank you all, and thanks to this year's symposium sponsors.

Make plans now to continue the conversation with us at next year's symposium. We will gather again June 20 and 21, 2017 in Denver, Colorado. In the interim, you'll want to explore the wealth of information and resources available from CPS online at www.centerforproducesafety.org.



Stephen F. Patricio
Chair, Board of Directors
Center for Produce Safety

Agenda at a Glance

Tuesday, June 28, 2016

7:00am – 8:00am

Registration, Continental Breakfast, Poster Session

8:00am – 8:15am

Welcome - Stephen Patricio, Chair, Center for Produce Safety
Grand Ballroom

8:15am – 9:30am

A Case Study - Part I: *Lm* Outbreak and Caramel Apples

Moderator: Bob Whitaker, Produce Marketing Association

Panelists: Patrick Kennelly, California Department of Public Health
Mark Powers, Northwest Horticultural Council
Katrina Reid, USDA Foreign Agricultural Service
Ian Williams, Centers for Disease Control and Prevention

9:30am – 10:00am

Break

10:00am – 11:30am

A Case Study - Part II: *Lm*, Caramel Apples and What We Learned

Moderator: Bob Whitaker, Produce Marketing Association

Panelists: Kathleen Glass, University of Wisconsin
Ines Hanrahan, Washington Tree Fruit Research Commission
Trevor Suslow, University of California, Davis
Martin Wiedmann, Cornell University

11:30am – 12:45pm

Lunch

12:45pm – 2:15pm

Session #1: Surrogates and Indicators

- Enteric viruses as new indicators of human and cattle fecal contamination of irrigation waters
Kelly Bright, The University of Arizona
- Investigation of risk criteria and foodborne pathogen reduction practices for irrigation water
Steven Rideout, Virginia Tech
- Selection of *E. coli* surrogates with attachment and survival patterns similar to those of human pathogens associated with produce
Kimberly Cook, USDA Agricultural Research Service
- Rapid bacterial testing for on-farm sampling
Sam Nugen, University of Massachusetts

Agenda at a Glance

Moderator: Martha Roberts, University of Florida

Panelists: DeAnn Davis, Earthbound Farm, WhiteWave Food Company
Robert Mandrell, USDA Agricultural Research Service (Retired)
Craig Wilson, Costco Wholesale

2:15pm – 2:45pm

Lightning Round and Poster Brief

Moderator: Joan Rosen, JC Rosen Resources

2:45pm – 3:15pm

Break

3:15pm – 5:05pm

Session #2: Irrigation Water Management

- Demonstration of practical, effective and environmentally-sustainable agricultural water treatments to achieve compliance with microbiological criteria
Ana Allende, CEBAS-CSIC, Spain
- Evaluation of multiple disinfection methods to mitigate the risk of produce contamination by irrigation water
John Buchanan, University of Tennessee
- Improved sampling and analytical methods for testing agricultural water for pathogens, surrogates and source tracking indicators
Amy Kahler, Centers for Disease Control
- Evaluation of an alternative irrigation water quality indicator
Trevor Suslow, University of California, Davis
- Optimal strategies for monitoring irrigation water quality and the development of guidelines for the irrigation of food crops
Marc Verhougstraete, The University of Arizona

Moderator: Hank Giclas, Western Growers

Panelists: Suresh DeCosta, Lipman Produce
Pascal Delaquis, Agriculture and Agri-Food Canada
Keith Refsnider, Driscoll's

5:05pm – 5:10pm

Announcements: **Bonnie Fernandez-Fenaroli, Executive Director Center for Produce Safety**

5:10pm – 6:30pm

Reception

Agenda at a Glance

Wednesday, June 29, 2016

7:00am – 8:00am

Continental Breakfast, Poster Session

8:00am – 9:15am

Session #3: Process Validation and Verification

- Impact of wash water disinfectants on *Salmonella enterica* transfer and survival in mango packing facility water tank operations
Mary Anne Amalaradjou, University of Connecticut
- Improving pasteurization validation methods for pistachio processing
Bradley Marks, Michigan State University
- Validation of chlorine level in sanitization system to avoid cross-contamination
Qin Wang, University of Maryland

Moderator: Robert Gravani, Cornell University

Panelists: Robert Mandrell, USDA Agricultural Research Service (Retired)
Walter Ram, Giumarra Companies
Brian Zomorodi, Apio, Inc.

9:15am – 9:50am

Lightning Round and Poster Brief

Moderator: Tiffiani Miller, Florida Department of Agriculture and Consumer Affairs

9:50am – 10:20am

Break

10:20am – 11:30am

Preventive Control, Validation and Verification: Where Do We Go From Here?

Moderator: Jim Gorny, Produce Marketing Association

Panelists: Jim Brennan, SmartWash Solutions
MaryLou Tortorello, U.S. Food and Drug Administration
Brian Zomorodi, Apio, Inc.

11:30am – 12:45pm

Lunch

12:45pm – 2:00pm

Learnings Day 1 and Emerging Issues

Agenda at a Glance

Moderator: Drew McDonald, Church Brothers/True Leaf Farms

Panelists: Elizabeth Bihn, Cornell University
Tiffiani Miller, Florida Department of Agriculture
and Consumer Affairs
Vic Smith, JV Farms
Bob Whitaker, Produce Marketing Association
Tim York, Markon Cooperative

2:00pm – 2:35pm

Lightning Round and Poster Brief

Moderator: Stacy Stoltenberg, DuPont Nutrition & Health

2:35pm – 3:05pm

Break

3:05pm – 4:20pm

Session #4: Animal Intrusion and On-Farm Pathogen Detection

- Contamination of leafy green crops with foodborne pathogens:
Are wildlife a problem?
Alan Franklin, USDA APHIS WS, National Wildlife Research Center
- Validation of geospatial algorithms to predict the prevalence and persistence
of pathogens in produce fields to improve GAPs
Martin Wiedmann, Cornell University
- Effect of physiochemical and biological parameters on survival, persistence and
transmission of norovirus in water and on produce
Melissa Jones, University of Florida

Moderator: Francisco “Chato” Valdes, Sabor Farms

Panelists: Samir Assar, Food and Drug Administration
Michele Jay-Russell, University of California, Davis
Robert Sakata, Sakata Farms

4:20pm – 4:40pm

Today’s Learnings and Conclusion: Drew McDonald, Chair, Center for Produce Safety Technical Committee

4:40pm – 6:00pm

Reception

General Session



SURROGATES AND INDICATORS

Project Title

Enteric viruses as new indicators of human and cattle fecal contamination of irrigation waters

Principal Investigator

Kelly Bright, The University of Arizona

Project Term

January 1, 2015 – December 31, 2016

Non-Technical Summary

The standards used by the produce industry to detect fecal contamination in irrigation waters (by indirectly testing for indicator organisms) are based on tests developed for drinking waters rather than surface waters, and include risk threshold levels established by the Environmental Protection Agency for recreational (bathing) waters. This contamination threshold is set with little scientific evidence for risk to human health from potentially contaminated irrigation water for food crops. Thus, it may not be appropriate for determining if there is a “risk relevant” level of contamination for crops irrigated with waters tested in this manner. To improve these regulations we will use novel viral targets that have shown to better correlate with the presence of fecal material, and evaluate them for potential use as more sensitive and specific detection methods for evaluating the safety of irrigation waters. This work will evaluate the accuracy of these novel indicator viruses and optimize the methods required for field use. This information may allow the produce industry valuable exposure data on the presence/absence and quantity of fecal contamination that may be present in irrigation

waters, and provide much needed improvements to the use of indicator organisms for evaluating irrigation water quality.

Funding

California Department of Food and Agriculture Specialty Crop Block Grant; Center for Produce Safety**

Acknowledgements

Marc Verhougstraete, The University of Arizona; Kelly Reynolds, The University of Arizona; Lisa Casanova, Georgia State University; Laura Suppes, University of Wisconsin

Biography

Dr. Kelly Bright is an Associate Research Professor at The University of Arizona housed in the Department of Soil, Water & Environmental Science. Her office and laboratory are located at the University’s newly built, state-of-the-art facility, the Water & Sustainable Technology (WEST) Center in Tucson, Arizona. Dr. Bright studies the occurrence, survival and fate of microbial pathogens in the environment (including in all types of water) and is involved in the development of improved methods for their detection. She is also interested in water and wastewater treatment processes, and the development of alternative disinfection technologies.

Contact

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Project Title

Investigation of risk criteria and foodborne pathogen reduction practices for irrigation water

Principal Investigator

Steven Rideout, Virginia Tech

Project Term

January 1, 2015 – December 31, 2015

Non-Technical Summary

Irrigation water is considered to be one of the main contamination sources of foodborne pathogens on produce. *Salmonella enterica*, *Escherichia coli*

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O157:H7, and *Listeria monocytogenes* are three common enteric pathogens that may exist in irrigation water, and are reported to be associated with produce contamination. Science-based data are needed to generate practical and accurate prediction methods and to establish effective strategies about decontamination of irrigation water to improve produce food safety. The purpose of this research project is to: 1) investigate practical criteria for the prediction of foodborne pathogens in irrigation pond and well water; 2) evaluate the efficacy of commercial sanitizers on the decontamination of three common foodborne pathogens, *Salmonella* spp., *E. coli* O157:H7, and *L. monocytogenes*, in irrigation well and pond water; and 3) provide education and training to stakeholders on improved agricultural practices to reduce food safety risks in irrigation water. The outcomes of this research will benefit stakeholders especially vegetable and fruit industries to reduce the contamination risks of foodborne pathogens during irrigation and achieve the new requirements of FSMA on produce safety.

Funding

California Department of Food and Agriculture Specialty Crop Block Grant; Center for Produce Safety**

Acknowledgements

CoPI Renee Boyer, Ph.D., Virginia Tech

Biography

At Virginia Tech since 2005, Steven Rideout Ph.D., is currently the Director of Virginia Tech's Eastern Shore Agricultural Research and Extension Center. Rideout believes it is essential that emphasis be placed on establishing strong communication outlets, and is using social media to enhance extension programming.

Contact

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Project Title

Selection of *E. coli* surrogates with attachment and survival patterns similar to those of human

pathogens associated with produce

Principal Investigator

Kimberly Cook, USDA, Agricultural Research Service

Project Term

January 1, 2014 – December 31, 2015

Non-Technical Summary

Despite continuing efforts to eliminate pathogen contamination of fresh produce, significant outbreaks continue to occur. Therefore, a research priority is to determine the source and duration of pathogen contamination in agricultural settings (i.e., in manures, soils and on plant surfaces). In-house research to determine critical control points and identify good agricultural practices benefits from the use of indicators as surrogates for pathogens due to reduced need for safety equipment and expensive supplies. Therefore, studies are needed to identify characteristics of indicators like *Escherichia coli* (*E. coli*) that contribute to their occurrence and survival in association with produce in a manner similar to that of pathogens. In this proposed research, we will compare behavior of *E. coli* strains with diverse physical, chemical and biological properties to that of pathogens when both are applied to soil in either manure or irrigation water. In this way we will: (1) identify survival and binding characteristics of surrogates that make them better indicators of produce associated pathogens; and (2) provide science based information on survival of pathogens and indicators in soil and on fresh produce when initially present in either applied manure or irrigation water.

Funding

Thanks to the Center For Produce Safety for funding this research. This work was also supported by research funds provided through the USDA Agricultural Research Service.

Acknowledgements

Co-PIs: Dr. Carl Bolster and Rohan Parekh, USDA Agricultural Research Service; Ritchie Taylor and Ethan Givan, Western Kentucky University; Dr. Sharon Walker and Holly Mayton, University of California, Riverside.

General Session

Biography

Dr. Cook is a Research Microbiologist and the Research Leader for the Bacterial Epidemiology and Antimicrobial Resistance Research Unit, USDA-Agricultural Research Service, U.S. National Poultry Research Center in Athens, GA. Cook conducts interdisciplinary research on: the microbiology of animal wastes; applying molecular biological methods to uncover reasons for the persistence and spread of pathogens and antibiotic resistant bacteria associated with livestock waste storage systems and applied manures; and works to find environmental isolates of common indicators to serve as better indicators of human pathogens associated with produce safety.

Contact

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Project Title

Rapid bacterial testing for on-farm sampling

Principal Investigator

Sam Nugen, University of Massachusetts

Project Term

January 1, 2015-December 31, 2015

Non-Technical Summary

Due to the sensitive nature of fresh produce, bacteriological safety tests which requires days for results are not practical tools for food safety. In order for a testing plan to present a pragmatic solution, it must be low-cost, reliable, robust and deliver rapid results. Our labs have been developing diagnostics to be used in non-laboratory settings by utilizing bacteriophages. These viruses can attack specific bacteria, replicate within them and then lyse the host while releasing hundreds to thousands of additional viruses. We are proposing the development of a dipstick test for the rapid detection of *Salmonella* spp. in agricultural samples. Following a sample pretreatment, the bacteriophages will be used to infect *Salmonella* spp. in the sample. Within 45 minutes, the increase in bacteriophage can be quantified with a simple

lateral flow device resembling a pregnancy test. Preliminary results for our *E. coli* sensor suggest a very low limit of detection.

Funding

California Department of Food and Agriculture Specialty Crop Block Grant; Center for Produce Safety**

Biography

Sam R. Nugen received his B.S. in Animal Science from the University of Vermont and his M.S. and Ph.D. in Food Science from Cornell University. He was previously a Research Engineer at Kraft Foods prior to returning to Cornell University to pursue his Ph.D., where he studied biosensor design. He is currently an Associate Professor at the University of Massachusetts, Amherst, where the Nugen Research Group focuses on rapid detection technology to monitor food and water safety and quality. The research includes microfluidics fabrication, magnetic nanoparticle synthesis, and bacteriophage engineering for bacteria separation and detection. Professor Nugen recently received the Future Leaders Award from the International Life Sciences Institute for his work on rapid bacteria detection. He now serves as a scientific advisor for the International Life Sciences Institute. In summer 2016, Professor Nugen will join the faculty of the Department of Food Science at Cornell University, where he will continue his work on pathogen separation and detection.

Contact

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General Session



IRRIGATION WATER MANAGEMENT

Project Title

Demonstration of practical, effective and environmentally-sustainable agricultural water treatments to achieve compliance with microbiological criteria

Principal Investigator

Ana Allende, CEBAS-CSIC, Spain

Project Term

January 1, 2015 – December 31, 2016

Non-Technical Summary

Growers should be assisted in determining the risk associated with agricultural water and the best mitigation option to remove pathogens if needed. Water disinfection is one of the most recommended intervention strategies for irrigation water. The main purpose of this project is to demonstrate a practical, effective, and environmentally-sustainable water disinfection treatment. In this regard, we propose the use of stabilized chlorine dioxide (ClO₂) as a suitable disinfection treatment. We will try to establish whether stabilized ClO₂ could be a suitable disinfection treatment to assurance the compliance with the established microbial limits, particularly fecal indicator bacteria such as *E. coli*. First, agricultural waters from different water sources will be characterized by microbiological and physicochemical parameters. Optimal operational conditions for stabilized ClO₂ as a suitable disinfection treatment will be established first at a pilot scale. After that, demonstration of practical, effective and environmentally sustainable agricultural water disinfection treatment will be carried out at commercial fields, where the impact of stabilized ClO₂

on the environment will be also evaluated. We believe that the obtained conclusions will be very valuable for growers, who will be able to integrate this technology in their water management practices.

Funding

Center for Produce Safety

Acknowledgements

Mabel Gil, Senior Researcher; Pilar Truchado, Postdoctoral Researcher; Francisco López-Gálvez, Postdoctoral Researcher; Irene Castro-Ibañez, Predoctoral Researcher; Trevor Suslow, Senior Researcher & Scientific Cooperator; STC, Industrial Partner; Primaflor, Industrial Partner.

Biography

Dr. Ana Allende is a Senior Researcher with CEBAS-CSIC (Spanish National Research Council) in Spain. She obtained her Ph.D. in Food Science and Technology at the University of Cartagena (Spain). She further pursued research as a postdoc of the Flanders Centre of Postharvest Technology, Katholieke Universiteit Leuven in Belgium and the Food Quality Lab/Environmental Microbial and Food Safety Lab at USDA, Baltimore. She has published more than 80 research articles about safety of fresh produce as well as pre- and post-harvest technological interventions in microbial ecology with more than 2100 cites. She has more than 16 years of scientific research and management of microbial safety and fresh produce projects. Allende holds several international positions such as: Vice-Chair of the international network BACFOONET (Cost-Action), which provides focus on mitigating bacterial colonization and persistence on foods and food processing environments; a member of the BIOHAZ panel at the European Food Safety Authority (EFSA); Vice-Director of the CEBAS-CSIC; and member of the editorial boards of the International Journal of Food Microbiology, the Postharvest Biology and Technology Journal, and the International Journal of Food Contamination.

Contact

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General Session

Project Title

Evaluation of multiple disinfection methods to mitigate the risk of produce contamination by irrigation water

Principal Investigator

John Buchanan, University of Tennessee

Project Term

January 1, 2014 – December 31, 2015

Non Technical Summary

Water used for frost protection and irrigation is one of the most likely points of pathogen contamination during fruit and vegetable production. Previous studies have focused on chemical rather than microbiological water-quality parameters. Consequently, a knowledge gap exists regarding surface water sanitary quality and the risks associated with the timing and method of application. In response to FDA's proposed standards for surface water quality, we propose to evaluate the adequacy of three in-line methods for disinfecting frost protection and irrigation water. An ultraviolet light module, a chlorine dioxide injection system, and a peroxyacetic acid injection system will be evaluated based on the reduction of indicator microorganisms (*E. coli* and fecal coliforms) and the presence or absence of pathogens (Shiga toxin-producing *E. coli* [STEC]) in a double-cropping system with strawberry and cantaloupe. These disinfection techniques will be compared to non-disinfected pond water with cattle access and populations of all organisms of interest. In addition to evaluating populations of microorganisms pre- and post-treatment, we will also sample plant tissue during flower, early fruit, peak fruit and late harvest to determine transfer rates of foodborne pathogens. Yield and quality characteristics for each crop among disinfection treatments will also be compared.

Funding

California Department of Food and Agriculture Specialty Crop Block Grant; Center for Produce Safety*

Acknowledgements

CoPI: Faith Critzer, University of Tennessee

Biography

Dr. John R. Buchanan is an Associate Professor and is on the faculty of the Biosystems Engineering and Soil Science Department at the University of Tennessee. He has 26 years of teaching, research and outreach experience in the areas of onsite and decentralized wastewater management, water quality and storm water engineering. Dr. Buchanan has B.S. and M.S. degrees in Agricultural Engineering and a Ph.D. in Civil Engineering, all from The University of Tennessee. John is a member of the Water Environment Federation, Soil and Water Conservation Society, NOWRA, and the American Society of Agricultural and Biological Engineers. He is a registered professional engineer in Tennessee.

Contact

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Project Title

Improved sampling and analytical methods for testing agricultural water for pathogens, surrogates and source tracking indicators

Principal Investigator

Vincent Hill, Centers for Disease Control and Prevention

Project Term

January 1, 2015 – December 31, 2016

Non Technical Summary

New rules proposed under the Food Safety Modernization Act (FSMA) establish monitoring frequencies and *Escherichia coli* (*E. coli*) concentrations for characterizing agricultural water quality. In addition to monitoring for *E. coli*, other strategies for collecting and testing irrigation water can provide farm operators with a better understanding of the quality of water used in crop production. These strategies include collecting source water samples during times of greater potential risk for contamination (e.g., after rain events), and testing for pathogens and alternative water quality surrogates. In this project, ultrafiltration will be used to collect large-volume irrigation water samples from three farms in Georgia to investigate the

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benefits of collecting such samples for microbial water quality testing. Baseline and precipitation-impacted samples will be collected to enhance the comparison of large- versus small-volume collection procedures. Samples will be tested for traditional indicators of fecal contamination (*E. coli* and enterococci), alternative surrogates of fecal contamination (F+ coliphages), pathogens (*Salmonella*, *Cryptosporidium* and *E. coli* O157:H7), and analytes that can be used to identify sources of fecal contamination affecting agricultural water quality. This study will result in development of sampling and testing procedures for analysis of large-volume irrigation water samples for alternative microbial water quality parameters.

Funding

California Department of Food and Agriculture Specialty Crop Block Grant; Center for Produce Safety**

Acknowledgements

Co-PIs: George Vellidis, University of Georgia Professor; CoPI: Karen Levy, Emory University, Amy Kahler, CDC Project Manager; Moukaram Tertuliano, UGA Postdoctoral Research Associate; Mia Mattioli, Emory Postdoctoral Fellow; Candace Miller, CDC ORISE fellow

Biography

Vincent Hill, Ph.D. is an environmental engineer in CDC's Waterborne Disease Prevention Branch (WDPB), and is the Acting Branch Chief for WDPB. Dr. Hill's research has focused on the development and application of environmental sampling methods, microbial detection methods, and treatment technologies for water, wastewater, and sanitation. Dr. Hill joined the Centers for Disease Control and Prevention in 2003, and became Acting Branch Chief in 2016. Dr. Hill received his Ph.D. in Environmental Science and Engineering from The University of North Carolina at Chapel Hill, School of Public Health in 2001, his MSE in Environmental Engineering from The Johns Hopkins University in 1991, and his BSE in Civil Engineering from Johns Hopkins in 1990. He is an author of over 100 peer-reviewed journal articles, scientific reports and patents focused on environmental microbiology and engineering.

Contact

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Project Title

Evaluation of an alternative irrigation water quality indicator

Principal Investigator

Trevor Suslow, University of California, Davis

Project Term

January 1, 2015 – December 31, 2016

Non Technical Summary

Water used in preharvest production of edible horticultural foods, fruits and vegetables, is universally recognized as a key potential hazard for widespread crop contamination with human foodborne pathogens. Industry guidance, standards and microbiological and sampling interval metrics uniformly identify nonpathogenic *E. coli* as the practical and cost-effective indicator of fecal contamination of a water source. Drawn from recreational water quality standards, numbers of *E. coli* can be associated with the presence of human pathogens. However, years of experience and tens of thousands of irrigation water tests demonstrate that the accuracy of current metrics to predicting risk to consumers following consumption of uncooked produce is very poor. Our project objective is to develop an initial baseline of comparative data for indicator *E. coli*, Total Bacteroides (an alternative and more robust indicator), in surface water sources to the presence of human pathogenic *E. coli* and *Salmonella* in water used for irrigation management, ag-chemical sprays, and other preharvest applications. Studies will be conducted in California, Arizona and selected regional production districts and diverse types of produce. This project would develop data to support academic, industry, and public health evaluations for the replacement of non-functional quantitative irrigation water standards with a simpler semi-quantitative threshold.

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Funding

California Department of Food and Agriculture;
Oregon Department of Agriculture and
Washington Department of Agriculture Specialty
Crop Block Grant Programs; Center for Produce
Safety**

Biography

Trevor Suslow, Ph.D., is an extension Research Specialist at the University of California, Davis with statewide responsibilities in quality and safety of perishable horticultural commodities. Dr. Suslow's program spans pre-harvest to postharvest research and outreach education on diverse fresh and minimally-processed horticultural foods from annual row crops to tree and vine commodities. He has served on the Center for Produce Safety (CPS) Board of Directors and Technical Committee since CPS's creation in 2008. His research combines lab and on-farm/packing facility research on *E. coli*, *Salmonella*, and *Listeria* in conventional and organic production systems, for the purpose of identifying opportunities for optimal microbial reductions and delivery of safe food to the consumer. Dr. Suslow received his B.Sc. in Agricultural Sciences (with High Honors) and a Ph.D. in Plant Pathology from the University of California, Berkeley. Dr. Suslow helped found and worked at advanced Genetic Sciences and DNA Plant Technology Corporation from 1981 to 1995 before joining UC Davis. Trevor was named to *Food Safety News's* list of The Best of Food Safety in education, and recently selected to *The Packer's* 25 Profiles in Leadership award.

Contact

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Project Title

Optimal strategies for monitoring irrigation water quality and the development of guidelines for the irrigation of food crops

Principal Investigator

Marc Verhougstraete, The University of Arizona

Project Term

January 1, 2015 – December 31, 2015

Non Technical Summary

The quality of irrigation water drawn from surface water sources can vary greatly. This is particularly true for waters that are subject to intermittent contamination events such as runoff or direct entry of livestock upstream of use. Such pollution in irrigation systems increases the risk of food crop contamination. A single sample does not adequately characterize the risk potential present in large irrigation systems often utilized in the Southwestern United States. Furthermore, current approaches are based on recreational water practices and have little scientific basis for irrigation waters. The goals of this project are to define optimal monitoring strategies for irrigation water quality and develop guidelines for the irrigation of food crops. We propose five key objectives that will improve our understanding of potential risk associated with fecal contamination in irrigation systems. These objectives include spatial and temporal analysis of *Escherichia coli* over multiple seasons and irrigation canals in Yuma, Arizona. Following water quality analysis, guidelines and best management practices will be developed for growers/producers to follow during the monitoring and use of irrigation water systems for food production. These guidelines will better characterize risks from microbial pathogen contamination in irrigation waters and aid in risk reduction practices for agricultural water.

Funding

Center for Produce Safety and The University of Arizona

Acknowledgements

Kelly Bright, CoPI; Kelly Reynolds, CoPI; Channah Rock, CoPI; Jonathan Sexton and Jennifer Pearce-Walker

Biography

Dr. Marc Verhougstraete's primary research has focused on environmental microbiology and water quality. To this aspect, he has focused primarily on understanding the sources, occurrence and transport of waterborne pathogens using fecal

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indicator organisms and molecular source tracking. His research interests also include the integration of microbial water quality with hydrological catchment dynamics, landscape patterns and Quantitative Microbial Risk Assessment to improve environmental management that protect human and ecosystem health. He has also investigated the effects of intervention practices in healthcare systems to reduce the transmission of pathogenic agents and associated healthcare infections. In all aspects of his research, Dr. Verhougstraete's primary objectives are to improve and protect human health through increased scientific understanding of complex environments using a multifaceted toolbox approach.

Contact

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PROCESS VALIDATION AND VERIFICATION

Project Title

Impact of wash water disinfectants on *Salmonella enterica* transfer and survival in mango packing facility water tank operations

Principal Investigator

Mary Anne Amalaradjou, DVM, Ph.D. , Assistant Professor, Department of Animal Science, University of Connecticut

Project Term

January 1, 2015 – December 31, 2016

Non Technical Summary

Foodborne outbreaks associated with consumption

of raw mangoes have been traced back to the use of contaminated wash water. This highlights the critical role of wash water disinfection in mango processing, affecting its quality and safety. While investigations on the efficacy of disinfectants to reduce pathogens on other fruits have been performed, no studies have been conducted on mangoes. Therefore, this study will investigate the efficacy of commonly-used water disinfectants (chlorine, peracetic acid and chlorine dioxide) for killing *Salmonella* on mangoes and prevention of water-to-mango cross-contamination. The study will be performed under conditions that simulate dump tank washing, hot water treatment and hydrocooling. It is expected that this study will provide insight into the efficacy of disinfectants to inactivate *Salmonella* in mango packing facility water operations. Furthermore, this proposal will help understand the role of organic load in mango wash water on disinfectant efficacy. In conclusion, the proposed research is expected to help develop best practices regarding post-harvest washing and disinfection of mangoes to control *Salmonella* and other potentially pathogenic organisms.

Funding

Center for Produce Safety, National Mango Board

Acknowledgements

Center for Produce Safety, National Mango Board

Biography

Dr. Mary Anne Amalaradjou's research primarily focuses on food microbiology and safety. Specifically her research is targeted towards understanding pathogen survival and persistence along the food chain, their virulence attributes and the application of natural antimicrobials and probiotics to control foodborne pathogens. She also studies the efficacy of currently applied intervention (hurdle) technologies to reduce transmission of pathogen during pre- and post-harvest processing of fresh produce, meat and dairy products. Beyond controlling pathogens in food systems her research also investigates the potential application of probiotics and protective cultures in the prevention and treatment of infectious diseases. Through all aspects of her

General Session

research, Mary Anne's main objective is to improve food safety and promote public health.

Contact

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Project Title

Improving pasteurization validation methods for pistachio processing

Principal Investigator

Bradley Marks, Michigan State University

Project Term

January 1, 2015 – December 31, 2016

Non Technical Summary

Microbial safety of low-moisture foods is a particularly difficult challenge, as reflected in recent outbreaks and/or recalls associated with *Salmonella*-contaminated nuts and other low-moisture products. Therefore, processing interventions are an emerging imperative to reduce the risk of *Salmonella* in low-moisture products, including pistachios. The Food Safety Modernization Act (FSMA) Preventive Controls in Human Foods rule will mandate that the low-moisture food industry implement and validate interventions against identified hazards, such as *Salmonella*. Although a number of pathogen-reduction technologies are available to the pistachio industry (e.g., dry heat, steam, radio-frequency), there are several significant problems: (1) no single technology will be universally applicable, so that product-specific/scalable solutions are needed; (2) the cost of stand-alone pasteurization technologies is an impediment to small processors; and (3) robust validation protocols have not been widely tested or disseminated. Therefore, the overall goal is to improve the methods for validating pathogen-reduction processes for pistachios, with particular attention to improving existing processes and enabling any processor to reliably validate those processes. The work plan includes laboratory- and pilot-scale experiments with *Salmonella*-inoculated

pistachios, and a process validation demonstration at the commercial-scale. A key project outcome will be guidelines for methods to validate preventive control measures for pistachios.

Funding

California Department of Food and Agriculture Specialty Crop Block Grant; Center for Produce Safety**

Acknowledgements

Co-PIs: Drs. Linda Harris, University of California, Davis and Elliot Ryser, Michigan State University, Collaborators: Andrew Howe, Hien Tran, Horizon Nut, LLC; Brad Robson, Buchanan Hollow Nut Co.

Biography

Dr. Bradley Marks is a professor of Biosystems Engineering and Food Science at Michigan State University. Dr. Marks earned his undergraduate and graduate degrees at Michigan State University and Purdue University, respectively, and was previously an assistant and associate professor at the University of Arkansas. At Michigan State University, he leads an interdisciplinary research team focused on food safety engineering, particularly microbial inactivation modeling and improving methods for validating pasteurization processes for ready-to-eat foods. His current research primarily addresses engineering approaches to improve pasteurization processes for low-moisture products.

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Project Title

Validation of chlorine level in sanitization system to avoid cross-contamination

Principal Investigator

Qin Wang, University of Maryland

Project Term

January 1, 2015 – December 31, 2016

General Session

Non Technical Summary

Scientifically validated data are needed by regulators and commercial fresh-cut processors to determine the minimum chlorine concentration required to prevent pathogen cross-contamination in produce wash waters. This project will address this issue by development of a microfluidic mixer that simulates cross-contamination and pathogen survival scenarios in chlorinated produce wash water. The microfluidic mixer has the unique capability of manipulating solutions at a miniaturized scale within instantaneous response times. Thus, the mixer will provide a technological solution to the limitations encountered in macroscale testing. This project will investigate the relationship between contact time (0.1 second – 5 minutes) and chlorine level (0.125 to 50 ppm) to prevent cross-contamination in wash water. Minimal contact times for given chlorine levels will be determined for planktonic and biofilms of bacterial cells. Results will be further validated using industrial produce wash water to investigate the effects of operational variables (pH, temperature, organic load) on the contact time requirement at different chlorine levels. We anticipate the study will provide insight on the relationship between minimal contact time and chlorine level, and therefore predict the processing requirement at given variables to effectively prevent cross-contamination in wash water.

Funding

Center for Produce Safety and University of Maryland

Acknowledgements

Dr. Yaguang (Sunny Luo), Research Food Technologist, USDA Agricultural Research Service; Dr. Patricia Millner, Research Microbiologist, USDA Agricultural Research Service; Dr. Boce Zhang, ORISE Fellow, USDA Agricultural Research Service; Dr. Bin Zhou, Research Microbiologist, USDA Agricultural Research Service; Dr. Zi Teng, Post-doctoral Research Associate, University of Maryland, University of Maryland NanoCenter and Fabrication Lab

Biography

Dr. Qin Wang obtained her Ph.D. in food science

from the University of Illinois at Urbana-Champaign in 2004. She joined the Department of Nutrition and Food Science at University of Maryland as an Assistant Professor in 2008. From 2014, she is an Associate Professor of Food Nanotechnology/ Food Chemistry. Dr. Wang's research has been focused on food biopolymers and food safety. Her research covers a broad scope of multidisciplinary areas including food science, materials science and engineering, nanotechnology, and biophysics.

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ANIMAL INTRUSION AND ON-FARM PATHOGEN DETECTION

Project Title

Contamination of leafy green crops with foodborne pathogens: Are wildlife a problem?

Principal Investigator

Alan Franklin, USDA APHIS WS, National Wildlife Research Center

Project Term

January 1, 2015 – December 31, 2015

Non Technical Summary

Foodborne diseases cause millions of illnesses in the United States each year and some of these cases result in severe sickness and death. We propose to study whether or not wildlife contributes to foodborne disease risk by contaminating leafy green produce, such as spinach and lettuce, when they visit agricultural fields. There have been several instances where foodborne disease outbreaks are

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thought to have been related to wildlife presence in crop fields, but these links are poorly understood. By collecting data on when wildlife enter agricultural production areas, what species enter, where they enter, and how many of them are present at a given point in time, we can better understand if and where introduction of pathogens causing foodborne diseases might occur. We will also collect fecal samples from wildlife visiting produce fields and test them for three of the top microbial pathogens causing foodborne disease. This information will provide needed insight into the magnitude of the problem and will determine if actions should be taken to limit this risk and what those actions should be. Overall, our results will help balance the coexistence of wildlife habitat with protection of agricultural producers and human health from food-borne pathogens.

Funding

California Department of Food and Agriculture Specialty Crop Block Grant; Center for Produce Safety**

Acknowledgements

Co-authors: Jeffrey Chandler, Bledar Bisha, Kurt Vercauteren, S. Colorado Farms; Amy Kunugi, National Wildlife Research Center; Kevin Bentler, Jeremy Ellis, Nicole Mooers, Lori McCurdy

Biography

Dr. Alan B. Franklin is a Supervisory Research Biologist and Project Leader for the Wildlife Pathogens and Food Security & Safety Project at the USDA Animal and Plant Inspection Services, Wildlife Services, National Wildlife Research Center at Fort Collins, Colorado. Prior to joining the National Wildlife Research Center, he was a Research Scientist at the Colorado Cooperative Fish and Wildlife Research Unit at Colorado State University. He received a B.S. in Wildlife Science from Cornell University, an M.S. in Wildlife from Humboldt State University, and a Ph.D. in Wildlife Ecology from Colorado State University. He currently holds adjunct faculty positions at Colorado State University, Humboldt State University and University of Minnesota. His current research interests in wildlife disease focus on the ecology of avian influenza and bacterial pathogens in wildlife

and the potential for transmission of pathogens from wildlife populations to agricultural operations and human populations. He also has a quantitative background in sampling design and statistics, especially focused on wildlife population dynamics.

Contact

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Project Title

Validation of geospatial algorithms to predict the prevalence and persistence of pathogens in produce fields to improve GAPs

Principal Investigator

Martin Wiedmann, Cornell University

Project Term

January 1, 2014 – December 31, 2015

Non Technical Summary

Foodborne pathogen contamination of produce in the production environment continues to present a considerable concern, and can lead to recalls or even outbreaks. There is a need for further development of science-based approaches to assist growers in minimizing the risk of produce preharvest contamination. The purpose of this project is to validate a GIS-based modeling tool that identifies specific locations and times on a produce farm where the prevalence of foodborne pathogens is elevated, and as a result, the risk of produce contamination is higher. This GIS tool can be applied to any location because it utilizes a farms unique combination of landscape characteristics (e.g., proximity to domestic animal operations), soil properties (e.g., soil moisture), and climate (e.g., precipitation) in its prediction process. The implementation of GIS by the produce industry will increase the understanding of factors that promote foodborne pathogen prevalence and persistence on fields, and will assist growers in focusing their food safety efforts using risk-based strategies. Growers will be able to target areas within their farms that are at high risk for contamination and implement more informed field management decisions and science-based

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strategies (e.g., alteration of cropping schemes) to limit potential produce contamination.

Funding

California Department of Food and Agriculture
Specialty Crop Block Grant; Center for Produce Safety*

Acknowledgements

CoPI: Randy Worobo

Biography

Dr. Wiedmann received a veterinary degree and a doctorate in Veterinary Medicine from the Ludwig-Maximilians University in Munich in 1992 and 1994, and a Ph.D. in Food Science from Cornell University in 1997. He currently is the Gellert Family Professor of Food Safety at Cornell. His research interests focus on farm-to-table microbial food quality and food safety and the application of molecular tools to study the biology and transmission of foodborne pathogens and spoilage organisms. His team has published 300 peer-reviewed publications, which have been cited 9,000 times. Dr. Wiedmann was a member of the Listeria Outbreak Working Group, which was honored by a USDA Secretary's Award for Superior Service in 2000. He is a fellow of the Institute of Technologists (IFT), a fellow of the American Academy of Microbiology (AAM), and a member of the International Academy of Food Science and Technology.

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Project Title

Effect of physiochemical and biological parameters on survival, persistence and transmission of norovirus in water and on produce

Principal Investigator

Melissa Jones, University of Florida

Project Term

January 1, 2014 – December 2015

Non Technical Summary

Noroviruses are the leading cause of diarrheal disease in the world, and many of the infections

begin with the consumption of contaminated food and water. Currently, it is widely known that norovirus is present in the natural environment, but it is unknown what environmental factors are able to decrease norovirus survival in irrigation waters or on produce and therefore prevent disease. In order to address this multi-faceted problem, this project brings together experts in the fields of food safety, foodborne disease and noroviruses. The proposed studies will test several conditions associated with irrigation water quality on their ability to impact norovirus survival in the water, on produce and transmission to a host. The identification of factors that reduce virus survival and/or disease will allow for the development of food and water intervention and treatment processes to reduce virus contamination – and thus reduce the incidence of norovirus disease.

Funding

California Department of Food and Agriculture
Specialty Crop Block Grant; Center for Produce Safety*

Acknowledgements

CoPI: Stephanie Karst

Biography

Dr. Jones earned her Ph.D. from the University of Florida investigating molecular mechanisms of pathogenesis in *Vibrio vulnificus*. She continued her research with *Vibrio* spp. at the University of North Carolina at Charlotte before returning to University of Florida as a Research Assistant Professor. In 2012 she joined the lab of Dr. Stephanie Karst and began her work with noroviruses.

Dr. Jones seeks to understand the characteristics and conditions which contribute to the extraordinary stability and infectivity of noroviruses and how these characteristics impact viral transmission to the host. Her most exciting accomplishment to date has been development of the first-ever *in vitro* culture system for human noroviruses and discovering the necessary role bacteria play in this pathogen's ability to infect. Currently, her work is focused on further dissecting the role bacteria play in enhancing norovirus stability and infectivity and how that relationship can be exploited to reduce pathogen survival and /or transmission.

Contact

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Panelist Biographies

SAMIR ASSAR, PH.D.

Dr. Assar is Director of the Produce Safety Staff in the Food and Drug Administration's (FDA) Center for Food Safety and Applied Nutrition. Since 2008, Dr. Assar has managed development of FDA's policy, regulation and guidance on produce safety, including those mandated by the 2011 Food Safety Modernization Act. Dr. Assar provides strategic leadership in developing plans for research, training, and compliance activities that target a safe and abundant produce supply. He is committed to enhancing partnerships with produce safety stakeholders, and has collaboratively forged initiatives and agreements aimed at protecting public health. Dr. Assar also serves as FDA's project leader for the Western Center for Food Safety at the University of California, Davis, the focus of which is on research, education and outreach on production agriculture and food safety issues. Dr. Assar received his M.S. and Ph.D. in Food Science from the University of Florida.

TONY BANEGAS

Mr. Banegas has worked in the food industry for over twenty years and joined Ready Pac in 2009. He has been responsible for Ready Pac's Quality Assurance and Food Safety activities in Irwindale and currently holds the position of Vice President, Quality Systems which oversees quality for Ready Pac facilities. Mr. Banegas actively works with key customers and industry associations and their respective technical councils striving towards continuous improvement in food safety. Key areas of focus have been in Environmental Monitoring, Field Sampling, Field Harvest Crew Training requirements, Cooler Standards, Validation and Verification standards for whole produce and fresh-cut processing

During his career, Tony has developed new products and implemented quality programs in the bakery, confectionary, snack food items and citrus industries. He successfully launched over 40 retail products during his tenure as the Director of Research & Development and Contract Manufacturing at Mauna Loa Macadamia Nut Inc. Additionally, Tony led the Sunkist Juice and Oils Beverage Business Unit as their Director of Technical Services where he was

instrumental in implementing flavor improvement technologies for NFC (Not From Concentrate) lemon and orange juices. He was actively involved in standardizing many policies and procedures for Sunkist juice processing facilities and led both plants to their highest third-party audit scores. Mr. Banegas holds a B.S. in Food Science from California Polytechnic State University, San Luis Obispo, is HACCP Certified, an SQF Practitioner and a Preventive Controls Qualified Individual.

ELIZABETH A. BIHN, PH.D.

Dr. Bihn is Director of the Produce Safety Alliance (PSA) based in the Department of Food Science at Cornell University. PSA is tasked with developing and delivering a national curriculum to assist growers with understanding and implementing practices to meet the Food Safety Modernization Act's Produce Safety Rule requirements. Dr. Bihn regularly conducts Good Agricultural Practices (GAPs) training programs for fruit and vegetable farmers throughout the nation, and develops educational materials to facilitate risk reduction on the farm. Her research has focused on surface water quality used in the production of fruits and vegetables. Dr. Bihn was recently named Executive Director of the Institute for Food Safety at Cornell University. She received her B.S. in Zoology from Ohio State University, M.S. in Horticulture from the University of Florida, and Ph.D. in Food Science from Cornell University.

JIM BRENNAN

Mr. Brennan is currently President of SmartWash Solutions, LLC (SWS), a food safety company founded by Taylor Fresh Foods, the parent of the Taylor Farms family of companies. SWS was established to commercialize revolutionary wash aid technology to the fresh food segment of the food industry. Before joining SWS, Mr. Brennan started a technical consulting firm, The Alliance of Technical Professionals (ATP), the focus of which is on helping small- and medium-size companies develop new food business while navigating operational, food safety and regulatory issues. Prior to establishing ATP, he has held domestic and

Panelist Biographies

international management positions with Gallo Winery, Dole Food Company and PepsiCo.

Mr. Brennan has over three decades of experience in new business development within the food industry, and has been intimately involved in launching product lines that today contribute over \$3 billion in annual revenue to their respective companies. Many of these products established completely new categories such as 100% blended fruit juices, frozen fruit novelties and ready-to-eat salads.

DE ANN DAVIS, PH.D.

Dr. Davis joined Earthbound Farm, WhiteWave Foods Company in December 2015. Most recently, she was the Chief Food Safety Officer at Kraft Foods Group, where she had responsibility for the scientific and technical basis for food safety and microbiological quality programs across all the Kraft Foods brands. At Kraft, Dr. Davis also served as co-lead for the industry FSMA working group for the Grocery Manufacturers' Association; the group developed industry comments and worked with FDA to shape the final FSMA regulations published earlier this year.

Dr. Davis has over 20 years of experience in the consumer product goods industry, leading global product safety and compliance organizations for companies such as Alberto Culver, Kimberly Clark, The Dial Corporation and Procter & Gamble. Her experience spans diverse product categories, including cosmetics, paper and non-woven materials, medical devices and cleaning products, as well as scientific disciplines including quality assurance, toxicology, microbiology, regulatory affairs, and product and process development. Dr. Davis earned her B.A. in Biology and Chemistry from Point Loma College in San Diego, and her Ph.D. from Texas A&M University, College Station. She has been certified as a toxicologist by the American Board of Toxicology since 1996.

SURESH DECOSTA

Mr. DeCosta recently joined Lipman Family Farms as Director of Food Safety. He is a recognized subject matter expert with the ability to lead cross-functional groups of suppliers and produce industry representatives. Mr. DeCosta has broad food science industry experience, including product development, beverage formulation, food irradiation, coffee blend management, Good Agricultural Practices and fresh cut processing. He leverages his holistic understanding of the supply chain from farm to fork to mitigate food safety risk, with an awareness of the impact to commercialization. He uses interpersonal skills to build consensus in technical and non-technical environments and to drive industry change.

Mr. DeCosta currently serves as the chairman of United Fresh Produce Association's (United Fresh) Food Safety and Technology Council, and also serves on United Fresh's Board of Directors. He has received multiple industry awards, including the United Fresh technical award for his leadership in helping standardize agricultural food safety practices.

Mr. DeCosta received a M.S. in Food Science from Chapman University and a B.S. in Environmental Science from Slippery Rock University.

PASCAL DELAQUIS, PH.D.

Dr. Delaquis is a Research Microbiologist with the Science and Technology Branch of Agriculture and Agri-Food Canada at the Summerland Research Centre in British Columbia. He carries out research on the ecology of human pathogens (primarily Shiga toxin-producing *Escherichia coli* and *Salmonella enterica*) in fresh fruit and vegetable production systems, and their fate during food processing and in food distribution chains, to support development of strategies to mitigate attendant risks to public health. He is presently studying the prevalence, genomic diversity and spatio-temporal distribution of waterborne Shiga toxin-producing *Escherichia coli* in mixed agricultural environments. Dr. Delaquis received his Ph.D. in Food Science from the University of

Panelist Biographies

Saskatchewan, and his M.S. in Food Science and B.S. in Microbiology from the University of Manitoba.

HANK GICLAS

Mr. Giclas serves as Senior Vice President of Strategic Planning, Science and Technology for Western Growers, a department he created and grew to help Western Growers become a leading trade association. This division now assists members with food safety, crop protection, environmental compliance, sustainability and a host of other areas where sound science and new technology must drive industry advancement, solutions and government policy. Mr. Giclas is also Executive Director for Western Growers' Center for Innovation & Technology, based in Salinas, Calif.

Mr. Giclas serves on many industry advisory boards and technical committees including the Center for Produce Safety (CPS), Western Institute for Food Safety and Security, Coalition for Urban and Rural Environmental Stewardship, and the Specialty Crop Committee serving the National Agricultural Research Education, Extension and Economics Advisory Board. He received his B.S. from The University of Arizona in Agricultural Education, and was a vocational agriculture instructor before coming to Western Growers.

KATHLEEN GLASS, PH.D.

Dr. Glass is Associate Director for the Food Research Institute at the University of Wisconsin-Madison. In this role, she directs research evaluating the microbiological safety of low-acid refrigerated and formulation-safe (shelf-stable) foods. She earned her Ph.D. in Food Science from the University of Wisconsin-Madison, and is active in many professional organizations including the Institute of Food Technologists, American Society for Microbiology, American Meat Science Association, American Dairy Science Association and AOAC. Dr. Glass served as 2004-2005 President of the International Association for Food Protection, and on scientific advisory committees including the National Advisory Committee for the Microbiological Criteria of Foods, the National

Research Council's (U.S. Department of Agriculture) Food Safety and Inspection Service Standing Committee on Food Safety, and the International Dairy Federation SCM Action Team on Shiga-Toxin Producing *Escherichia coli*. Dr. Glass is a regular instructor for the Microbial Challenge Testing of Foods Workshop, the Better Process Cheese School, Dairy Hazard Analysis and Critical Control Points, and the Food Safety and Meat Microbiology School.

JAMES R. GORNY, PH.D.

Dr. Gorny is Vice President, Food Safety & Technology for Produce Marketing Association (PMA), where his primary responsibilities are to assist produce industry members with issues associated with food safety, product quality, biotechnology, agricultural innovation, process and packaging technology, and environmental sustainability. Dr. Gorny is also a past chair and current member of the Center for Produce Safety Technical Committee. Additionally, he is a member of the PMA "crisis" team, which provides assistance to members during foodborne illness outbreaks and/or recalls and assists in crisis communications. Prior to joining PMA, Dr. Gorny served as the Senior Advisor for Produce Safety at FDA's Center for Food Safety and Applied Nutrition; he also served as the first Executive Director of the Postharvest Technology Research and Information Center at the University of California, Davis. Dr. Gorny received his Ph.D. in Plant Biology from the University of California, Davis in 1995, and B.S. and M.S. degrees in Food Science from Louisiana State University.

ROBERT GRAVANI, PH.D.

Dr. Gravani recently retired as Professor of Food Science and Director of the National Good Agricultural Practices (GAPs) Program at Cornell University, where he has been actively engaged in extension/outreach, teaching and research activities. He received a B.S. in Food Science from Rutgers University, and his M.S. and Ph.D. from Cornell University. Dr. Gravani has worked with all sectors of the food system, and

Panelist Biographies

developed innovative programs for constituents in production agriculture, food processing, food retailing and foodservice, as well as for regulatory agencies and consumers.

Dr. Gravani is currently Treasurer of the Institute of Food Technologists (IFT). He is Past President and Fellow of IFT, and the 2014 recipient of IFT's Calvert Willey Distinguished Service Award. Dr. Gravani is a Past President of the International Association for Food Protection and a Fellow of the association. He served on the National Advisory Committee on Microbiological Criteria for Foods, and also on the National Academy of Sciences (NAS) Committee on Review of Scientific Criteria and Performance Standards for Safe Foods; in addition, he chaired the NAS Subcommittee on Seafood, Produce and Dairy Products.

INES HANRAHAN, PH.D.

Dr. Hanrahan has been employed as a Project Manager by the Washington Tree Fruit Research Commission (WTFRC) since 2005. She has earned a Diploma in Agricultural Engineering from Humboldt University Berlin, Germany in 1999, and a Ph.D. in Horticulture from Washington State University in 2005. Her professional experience includes an extensive international background in practical and academic horticulture, including research, teaching, and consulting. Dr. Hanrahan's expertise includes management of technical projects related to temperate fruit quality, such as: apple fruit finish improvement; methods to prevent rain-induced cherry cracking; apple postharvest physiological disorder prevention; optimization of cropping and storage systems to produce consistently high yields of target fruit; management of plant material evaluation from breeding programs for commercial suitability; and applied food safety research in the areas of water quality, preharvest die-off and postharvest systems management. Overall, her primary focus is on managing various projects, expediting transfer of research results to implementation to provide an ongoing link between scientists and the industry, and to train the next generation of industry professionals.

MICHELE JAY-RUSSELL PH.D., DVM, DAVPM

Dr. Jay-Russell is a Research Microbiologist and Manager of the Western Center for Food Safety at the University of California, Davis. Prior to joining the center, she worked as a Research Scientist with the California Department of Public Health. Dr. Jay-Russell's current research interests include the molecular epidemiology of zoonotic and foodborne pathogens and relationships to the produce production environment. A key goal of her program is to assist in implementing the Food Safety Modernization Act's Produce Safety Rule by providing data from applied research, especially related to animal intrusions, raw manure and agriculture water. She also works closely with the industry to develop co-management approaches to protect fresh produce from microbial contamination, while at the same time promoting environmental stewardship on farms. Dr. Jay-Russell received her Doctorate of Veterinary Medicine (DVM) and M.S. of Preventive Veterinary Medicine (MPVM) in 1992, and her Ph.D. in Microbiology in 2011 from the University of California, Davis. She was board certified with the American College of Veterinary Preventive Medicine in 1997.

PATRICK KENNELLY

Mr. Kennelly is Chief of the Food Safety Section for the California Department of Public Health (CDPH), Food and Drug Branch. He is responsible for overseeing the department's statewide food

The Center for Produce Safety expresses their appreciation to the volunteers from Washington State University:

Manoella Cabral Mendoza

Hsieh-Chin Tsai

Kyi Ho Jeong

Lina Sheng

Lauren Walter

Panelist Biographies

safety operations, which include inspecting and investigating processed food manufacturers, distributors and water bottling plants; investigating food-borne illness outbreaks, food contamination and tampering events, and food recalls; and developing and delivering food safety education to the food processing industry. Mr. Kennelly serves as a Steering Committee member on the California Food Emergency Response Team, a joint U.S. Food and Drug Administration (FDA)-CDPH rapid response team that responds to foodborne illness outbreaks and product contamination events.

Mr. Kennelly is a member of the California Food and Agriculture Defense Steering Committee, and the California Organic Advisory Board. He serves on the Governing Council and is Co-Chair for FDA's Partnership for Food Protection, is a member of the Advisory Board for the Western Institutes for Food Safety and Security, and is a member of the Board of Directors for the Center for Produce Safety. Mr. Kennelly has previously served as President of the Western Association of Food and Drug Officials, and currently serves on that group's board as a Member at Large.

ROBERT MANDRELL, PH.D.

Dr. Mandrell served as Research Leader of the Produce Safety and Microbiology Research Unit at the U.S. Department of Agriculture (USDA) from 1998 until he retired from federal service in 2013. His research interests include: microbial food safety related to fresh produce, and the ecology and epidemiology of enteric pathogens in food production; genomics and biology of *Campylobacter*, *Listeria* and *Salmonella* species related to food; and high-throughput methods for detecting and characterizing foodborne pathogens. Prior to working with USDA, Dr. Mandrell's research at the Oakland Children's Hospital Research Institute involved studies of the human immune response to bacterial polysaccharide-conjugate vaccines and other topics; and at the Veterans Affairs Medical Center in San Francisco and Walter Reed Army Institute of Research, Department of Bacterial

Diseases in Washington, D.C., he studied the immunochemistry and biochemistry of surface glycolipids of pathogenic *Neisseria* and *Haemophilus* species. Dr. Mandrell received a B.S. in Microbiology from Ohio State University, and a Ph.D. from the School of Biochemistry at the University of Birmingham in the United Kingdom. He works part-time presently as a consultant on issues related to microbial food safety.

DREW MCDONALD

Mr. McDonald is Vice President Quality, Food Safety, & Regulatory Affairs at Church Brothers Farms, LLC. He has over 20 years' experience in fresh produce and fresh foods. He oversees the quality and food safety aspects of this large growing, harvesting and fresh-cut processing company. Mr. McDonald works with an impressive team to develop and manage appropriate and practical quality and food safety programs. Over the course of his career, he has worked with growers and processors of fresh produce items all over the world. Prior to Church Brothers, he worked for Danaco Solutions, an innovative produce procurement company. Mr. McDonald also worked for Taylor Farms for 10 years, where he was the Vice President of National Quality Systems. He currently serves on numerous food safety-related technical committees, and has participated in authoring many produce food safety guidelines. Mr. McDonald received his education from Lawrence University in Wisconsin.

TIFFIANI MILLER, PH.D.

Dr. Miller is Director of Food Safety for Florida Department of Agriculture and Consumer Services. She oversees food and meat inspection, dairy industry, chemical residue and food labs. She joined the department in 2012 after leading the foodborne outbreak investigation team for Florida Department of Health. Previously, she served as a Research Scientist at Michigan Public Health Institute, and has evaluated biological, environmental and climatological drivers of foodborne illnesses. Dr. Miller holds a Ph.D. in Comparative Medicine and Integrative Biology from Michigan State University, an M.S. in

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Environmental Health Science from University of Georgia, and B.S. in Chemistry from University of South Carolina.

MARK POWERS

Mr. Powers joined Northwest Horticultural Council as Vice President in 1999, and was promoted to Executive Vice President in 2014. As a policy advocate for Pacific Northwest tree fruit growers, packers and shippers, one of his primary responsibilities is to seek removal of the many barriers to trade facing apples, pears and cherries.

Prior to relocating to Yakima, Wash., Powers was employed by Continental Grain Company. Originally from rural Wisconsin, he is a former Peace Corps volunteer and graduate of Grinnell College, with a B.A. in Spanish and Environmental Studies. He later obtained an MBA from Thunderbird School of Global Management. His board and committee service includes: Agricultural Technical Advisory Committee for Trade in Fruits and Vegetables, chairman from 2004-2011; Coalition to Promote U.S. Agricultural Exports as Chairman; National Council of Agricultural Employers Executive Committee; Tree-Fruit Technical Advisory Council Secretary; United Fresh Produce Association's Government Relations Council, and Supply Chain Logistics & Technology Council; U.S. Agricultural Export Development Council Executive Committee; U.S. Apple Association's Government Affairs Committee; and Washington State Department of Agriculture's International Marketing Advisory Committee.

KEITH REFSNIDER

Mr. Refsnider is Director of the Global Food Safety Program for Driscoll's, headquartered in Watsonville, Calif. Prior to joining Driscoll's in 2004, he held various positions in the food industry working in research and development, quality assurance and regulatory compliance roles. Mr. Refsnider currently serves on several food safety-related technical committees including the Center for Produce Safety's Technical Committee, Produce Marketing Association's Food Safety, Science

and Technology Committee, and the GlobalGAP Technical Committee for Crops. Mr. Refsnider has worked in the food industry for 34 years since graduating from Penn State University.

WALTER RAM

Mr. Ram is Vice President of Food Safety at The Giumarra Companies and has been with Giumarra since 1995. He is responsible for food safety and regulatory affairs for Giumarra's 15 operating divisions, and is active in food safety and food defense work at the industry level. Giumarra is one of the world's largest table grape producers, and is a major supplier of over 60 fresh fruits and vegetables from a dozen countries. His current industry activities include: Center for Produce Safety's Technical Committee; Produce Marketing Association Food Safety, Science and Technology Committee; Fresh Produce Association of the Americas Board of Directors; and Canadian Produce Marketing Association Food Safety Committee. Previous industry activities have included: chairman of United Fresh Produce Association's Food Safety and Technology Council; contributor and editor of *Commodity Specific Guidelines for the Fresh Tomato Supply Chain*; contributor to *Commodity Specific Guidelines for the Melons Supply Chain*; member of the steering committee for the National Mango Board; and Strategic Partnership Program for Agroterrorism (a joint government/industry program).

KATRINA REID

Ms. Reid is an International Trade Specialist at the U.S. Department of Agriculture (USDA) Foreign Agricultural Service, where she currently works on sanitary and phytosanitary international trade policy and issues. Prior, she has worked as USDA's International Trade Specialist on other international trade policy and issues, and has held positions there as a Chief of Staff, Management Analyst and Agricultural Marketing Specialist. Ms. Reid received a B.A. from the University of Virginia and an MBA from MIT.

Panelist Biographies

MARTHA RHODES ROBERTS, PH.D.

Dr. Roberts is Special Assistant, Government Affairs, at the University of Florida Institute of Food & Agricultural Sciences. She is head of Roberts Associates, and is a member of Food Foresight, a food trends analysis group. A Certified Food Scientist, Dr. Roberts is a member of the Center for Produce Safety's Executive and Technical Committees. She is a former Florida Assistant and Deputy Commissioner of Agriculture from 1984-2003. Dr. Roberts is a member of the Florida Agricultural Hall of Fame, and has received multiple state/federal/ industry service awards. She is the current Chair for National Association of State Departments of Agriculture's Food Safety Modernization Act Implementation Group. She is former President of the Association of Food and Drug Officials' Conference for Food Protection, and previously served on U.S. Food and Drug Administration, U.S. Department of Agriculture and Institute for Food Technologists committees as well as the National Advisory Committee on Microbiological Criteria for Foods FDA Advisory Panel. She is a member of the National Academy of Sciences Institute of Medicine panel (FDA's role in ensuring food safety), as well as the Farm Foundation. Dr. Roberts holds a M.S. and Ph. D. in Microbiology from the University of Georgia and a public health postdoctoral.

JOAN ROSEN

Ms. Rosen is the founder of JC Rosen Resources, a consulting firm that provides services globally with expertise in food safety, quality systems, postharvest technology, and regulatory affairs for the fresh produce and food industries. Previously, Ms. Rosen was Director of Global Food Safety and Quality for Chiquita Brands International/Fresh Express, where for over 22 years she had increasing responsibilities in key management leadership positions. She received her M.S. in Food Science and Postharvest Physiology from the University of California, Davis, and her B.S. in Food Science from Cornell University. Ms. Rosen is the 2004 recipient of the International Fresh-Cut Produce Association's Technical Excellence Award for her achievements in advancing the common good of the fresh-cut industry, enhancing

food safety and quality initiatives and supporting innovative technological advancements. Previously, she led postharvest research programs at Campbell Soup Company, and also worked in flavor development and application at Florasynth Inc.

ROBERT SAKATA

Mr. Sakata is owner of Sakata Farms in Brighton Colo. He is founding President of the Board of Directors for the Colorado Fruit & Vegetable Growers Association, Treasurer of the New Brantner Ditch Board, and serves on the Board of Trustees for the National Onion Association. In addition, he sits on the Fulton Ditch and Colorado Water Congress Board of Directors, as well as the Colorado Agriculture Water Alliance Executive Committee. Mr. Sakata served the state of Colorado on the Water Quality Control Commission (WQCC) for 15 years, appointed to that position by three different state governors. The WQCC is charged with setting the water quality standards, protecting designated uses for the state's waters. While studying at the Molecular Cellular & Developmental Biology Department at University of Colorado, Mr. Sakata worked for AMGEN when they opened their research labs in Boulder. Currently, Sakata Farms grows fresh market sweet corn, dry bulb onions, winter wheat, grain corn, pinto beans and barley.

VIC SMITH

Mr. Smith is President and CEO of JV Smith Companies, a diverse group of operations with farming, cooling and distribution facilities and shipping capacities in Arizona, California, Colorado and Baja, Mexico. Skyview Cooling was the company's first operation, formed in 1970 as a cooling company in Colorado and New Mexico. By 1977, it had expanded to Yuma, and then in 1982 it began operations in northern Mexico. Today, JV Smith Companies farm a number of commodities including conventional romaine, iceberg lettuce, spinach, potatoes, mixed leaf and organic spring mix, carrots, celery, romaine and green onions.

Mr. Smith studied Economics and Business Law

Panelist Biographies

at the University of Colorado from 1970-1974. He went on to study Finance at Arizona State University in 1975. Since 1991, he has overseen all the companies' farming, packing and cooling operations, including 20,000 acres of vegetable production annually. Mr. Smith is on the Board of Directors for Western Growers. He is also a member and previously served on the boards of both United Fresh Produce Association and Produce Marketing Association.

STACY K. STOLTENBERG

Ms. Stoltenberg is a Strategic Technical Sales Manager for DuPont Nutrition & Health Molecular Diagnostics division. The division is dedicated to food safety and protection through safe, accurate and easy-to-use diagnostic testing solutions. For the past five years, she has been dedicated to working with food companies and third-party laboratories to help make faster release decisions while testing their food products for harmful pathogens. Prior to her work with DuPont, Ms. Stoltenberg worked in business development/sales and as the lead Microbiologist at PrimusLabs for nine years. Ms. Stoltenberg received her B.S. and M.S. from Kansas State University in Food Science and Microbiology.

TREVOR SUSLOW, PH.D.

Dr. Suslow is an Extension Research Specialist at the University of California, Davis with statewide responsibilities in quality and safety of perishable horticultural commodities. Dr. Suslow's program spans preharvest to postharvest research and outreach education on diverse fresh and minimally-processed horticultural foods, from annual row crops to tree and vine commodities. He has served on the Center for Produce Safety Board of Directors and Technical Committee since its creation in 2008. His research combines lab and on-farm/packing facility research on *E. coli*, *Salmonella*, and *Listeria* in conventional and organic production systems, for the purpose of identifying opportunities for optimal microbial reductions and delivery of safe food to the consumer. Dr. Suslow received his B.S. in Agricultural Sciences with high honors, and a Ph.D. in Plant Pathology from the

University of California, Berkeley. Dr. Suslow helped found and worked at Advanced Genetic Sciences and DNA Plant Technology Corporation from 1981 to 1995 before joining UC Davis. Trevor was named to *Food Safety News*' list of "The Best of Food Safety in Education", and was recently selected for *The Packer's* 25 Profiles in Leadership award.

MARY LOU TORTORELLO, PH.D.

Dr. Tortorello is Chief of the Food Technology Branch for Food and Drug Administration's Division of Food Processing Science and Technology in Bedford Park, Ill. The division conducts research investigations on various aspects of food processing and preventive controls related to food safety. Dr. Tortorello coordinates the food microbiology research program for the division. Her research interests include the behavior and control of microbial pathogens in foods and food processing environments, as well as the improvement of food microbiological methods. She received a Ph.D. from the Department of Microbiology at Cornell University, and her professional background includes diagnostic product management at Abbott Laboratories. She is the Editor of *Food Microbiology*, Co-Editor of *Compendium of Methods for the Microbiological Examination of Foods* and *Encyclopedia of Food Microbiology*, and she serves on the Editorial Board of *Journal of Food Protection*.

FRANCISCO "CHATO" VALDES

Mr. Valdes is Director of Food Safety, Quality and Organic Compliance for Sábór Farms, LLC. He has 20+ years' experience in the produce industry, ranging from growing, harvesting and processing of fresh-cut produce in the Salinas Valley and Northern Baja California, Mexico. Currently he is pursuing an M.S. in Food Safety from Michigan State University. Prior to joining Sábór Farms Chato worked at Promotora Agricola el Toro, Gourmet Vegpaq, River Ranch Fresh Foods and Taylor Farms. He is currently a member of the California Leafy Greens Marketing Agreement Technical Committee, Hartnell College Food Safety Committee and the Grower Shipper Association's

Panelist Biographies

Food Safety Committee. He was also a contributor to the GAP Harmonization Initiative, and was involved in several commodity-specific food safety guidelines.

BOB WHITAKER, PH.D.

As Chief Science & Technology Officer for Produce Marketing Association (PMA), Dr. Bob Whitaker oversees PMA's food safety and technology efforts across the produce supply chain. This work focuses on delivering education content, and connecting members to technical solution providers. Before joining PMA, Dr. Whitaker held various scientific and senior management positions at DNA Plant Technology Corporation, and senior operation and technical functions at NewStar Fresh Foods. Dr. Whitaker served as Chairman of the Board of Directors for the International Fresh-Cut Processing Association (IFPA), and was a board member for the United Fresh Produce Association. In 2006, he was awarded IFPA's Technical Achievement Award for his work in food safety and product development. Dr. Whitaker has worked on a number of industry and government food safety and technology initiatives. He was named to the Executive Committee for the Center for Produce Safety (CPS) in 2007, and served as Chairman of the CPS Technical Committee 2008-2013. Dr. Whitaker received his Ph.D. in Biology from State University of New York at Binghamton.

MARTIN WIEDMANN, PH.D., DVM

Dr. Wiedmann received a veterinary degree and a Doctorate in Veterinary Medicine from the Ludwig-Maximilians University in Munich in 1992 and 1994, and a Ph.D. in Food Science from Cornell University in 1997. He currently is the Gellert Family Professor of Food Safety at Cornell. His research interests focus on farm-to-table microbial food quality and food safety, and the application of molecular tools to study the biology and transmission of foodborne pathogens and spoilage organisms. His team has published 300 peer reviewed publications, which have been cited 9,000 times. Martin was a member of the *Listeria* Outbreak Working Group, which was honored by a U.S. Agriculture Secretary's Award for Superior

Service in 2000. He is a Fellow of the Institute of Technologists, a Fellow of the American Academy of Microbiology, and a member of the International Academy of Food Science and Technology.

IAN WILLIAMS, PH.D.

Dr. Williams is Chief of the Outbreak Response and Prevention Branch at the Centers for Disease Control and Prevention (CDC) in Atlanta, Ga. He helps coordinate a national network of epidemiologists and other public health officials who investigate outbreaks of foodborne, waterborne and other enteric illnesses in the United States. Dr. Williams is a graduate of CDC's Epidemic Intelligence Service Program. He received a Ph.D. in Infectious Disease Epidemiology from the Johns Hopkins School of Hygiene and Public Health, and an M.S. in Preventive Medicine from the Ohio State University. He has worked at the CDC since 1994, and has been involved in a number of multistate outbreak investigations leading to the identification and recall of food products.

CRAIG WILSON

Mr. Wilson is Costco Wholesale Corporation's Vice President, General Merchandising Manager of Quality Assurance/Food Safety, Non-Foods Quality Assurance, Environmental Services/Haz Mat and Merchandise Services. Costco operates membership warehouses worldwide that offer a selection of branded and private-label products in a range of merchandise categories. Costco is a global leader in food safety, and all suppliers must meet the company's strict compliance requirements. Costco is well known industrywide for its food safety audit systems, Shiga toxin-producing *Escherichia coli* testing of fresh foods, x-ray product inspection, and unique positions on the Global Food Safety Initiative and the global regulatory environment. Prior to joining Costco, Mr. Wilson worked as a Special Projects Director for Frigoscandia Equipment Food Safety Systems for over 24 years. During his time with Frigoscandia, Craig published numerous research papers in the areas of food safety and food processing. He holds many patents, the most notable for steam pasteurization of food. Mr. Wilson is the recipient of the Gia/Matek

Panelist Biographies

Global Excellence in Food Safety Award, and serves on the Steering Committee for the National Food Safety Consortium as well as the Technical Committee of the Global Food Safety Initiative.

TIM YORK

Mr. York is President of Markon Cooperative, Inc. Markon is a purchasing, marketing and logistics cooperative serving North America's leading independent foodservice distributors. Based in Salinas, Calif., Markon distributes produce to over 70 facilities in the United States and Canada. Mr. York has nearly 40 years' experience in the produce and foodservice industries. He began his career in 1977 at H. Hall & Company, a grower/shipper of strawberries and mixed vegetables. Mr. York joined Markon in 1985 as Purchasing Director. He was promoted to his current position of President in 1990. Mr. York has held numerous committee and task force positions, including Chairman of the Produce Marketing Association (PMA) (2002-2003) and Chairman of PMA's Foodservice Division (1994-1996); he is also a member of U.S. Department of Agriculture's Fruit and Vegetable Advisory Council. He is currently a member of the Canadian Produce Marketing Association Board of Directors.

BRIAN ZOMORODI

Mr. Zomorodi is a 32-year veteran of the fresh-cut produce industry. He joined Apio Inc., a leader in fresh-cut vegetables and salads, in 2015 as Vice President of Quality and Food Safety. He started his career with Ready Pac in 1984, where he developed and led its research and development, quality assurance and food safety departments as Senior Vice President for 31 years. Mr. Zomorodi has been responsible for launching several successful fresh-cut product lines for the retail and foodservice industry, and for developing many food safety and quality assurance systems. He has been actively involved in establishing standards and guidelines for fresh-cut produce, and has been published many times. Mr. Zomorodi, who holds a M.S. in Food Science, is a recipient of many distinguished awards. He has actively served on a number of technical councils for trade organizations including Produce Marketing Association, United Fresh Produce Association and global food service companies such as McDonald's and YUM! brands.



CPS Research Symposium 2015

Poster Session



Identification of Novel Indicator Organisms to Determine the Risks of Fecal Contamination of Irrigation Waters***

Contact

Kelly Bright, The University of Arizona
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Project Date

January 1, 2016 – December 31, 2017

Summary

The methods used to detect *E. coli* were developed for drinking water, and are known to produce high levels of false-positive and false-negative results when used for irrigation waters. Therefore, growers are required to make decisions about water quality/safety based on inaccurate tests. Our project goal is to identify microorganisms which may be used as novel indicators of the presence of pathogens (not just fecal contamination) in irrigation waters, to allow the produce industry to make more accurate risk-based assessments to determine when it is safe to irrigate crops. A comparison of the microbial communities between irrigation water samples that are positive and negative for the presence of pathogens (both culturally and via DNA sequencing) will be conducted and analyzed to identify groups of organisms or specific species whose presence correlate well (both presence/absence and relative abundance) with the occurrence of foodborne pathogens, and that could potentially be used as novel indicators of irrigation water quality.

Poster Session

Microbial Food Safety Risks of Reusing Tail Water for Leafy Green Production***

Contact

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Project Date

January 1, 2016 – December 31, 2017

Summary

The use of sprinklers and furrow irrigation frequently results in significant volumes of run-off, also referred to as tail water. Although vegetable growers have made much progress in reducing irrigation run-off by using drip irrigation, overhead sprinklers are needed to germinate and establish crops, and to water high-density leafy greens such as spinach and baby greens. Many Central Coast ranches have infrastructure for reusing tail water to irrigate crops, including sediment basins, reservoirs and pumping systems. Even during the prolonged drought in California, growers were reluctant to irrigate crops with tail water due to a lack of information on microbial food safety risks. The overall goal of this project is to evaluate the food safety risks of using tail water to irrigate leafy green crops using conventional irrigation and production practices. During the first year of the project we are characterizing the chemical and microbial populations in run-off from commercial vegetable farms located in the Salinas Valley.

Factors that Influence the Introduction, Fate and Mitigation of Foodborne Pathogens on Mangoes throughout the Production Chain

Contact

Michelle Danyluk, University of Florida
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Project Date

January 1, 2016 – December 31, 2017

Summary

Understanding the persistence and mitigation of foodborne pathogens on the surface of mangoes is essential to the establishment of Best Management Practices for the responsible handling, packing, distributing and importing of mangoes and a fundamental management prerequisite to providing customers with safe mangoes. There is inadequate science-based data to establish management standards and criteria for mangoes to meet pending requirements of the Food Safety Modernization Act. The purpose of this research project is to evaluate the persistence of foodborne pathogens on the surfaces of whole and fresh-cut mangoes, assess potential mitigation strategies for control of pathogens on the surface of mangoes, and appraise the ability of *Salmonella* to infiltrate into mangoes under standard packinghouse conditions and to determine the fate of the internalized cells. The data resulting from the proposed research will specifically address data gaps the National Mango Board currently faces, and provide research-based metrics to validate mitigation strategies.

Poster Session

Identification of Novel Indicator Organisms to Determine the Risks of Establishing Die-Off Rates of Surrogate and Virulent EHEC-STEC Strains from Strawberry and Cilantro Surfaces: Time, Inoculum Dose and Chemical Intervention: Proof of Concept

Contact

Eduardo Gutierrez-Rodriguez, North Carolina State University
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Project Date

January 1, 2016 – December 31, 2016

Summary

The fresh produce industry is facing major changes in production practices due to the implementation of the Food Safety Modernization Act (FSMA). Within the new rules, the standards associated with water quality are among the most contested by industry. Current guidelines require water that will be in direct contact with the crop, to meet the EPA's 2012 recreational water standards. An alternative provision to comply with these rules includes an on-the-field microbial die-off rate between the last irrigation and harvest over no longer than four consecutive days when water cannot meet these standards. However, science-based information is needed to support this potentially useful provision, especially for cilantro and strawberry crops where few or no further disinfection steps are commercially available after harvest. This research focuses on optimizing the existing knowledge in microbial die-off of EHEC-STEC microorganisms to determine if this FSMA alternative provision is a safe farm practice when using water that cannot meet the EPA standards.

Assessing Postharvest Food Safety Risks and Identifying Mitigation Strategies for Foodborne Pathogens in Pistachios*

Contact

Linda Harris, University of California, Davis
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Project Date

January 1, 2014 – December 31, 2016

Summary

Growth curves were determined for *Salmonella*, and in some cases *Escherichia coli* O157:H7, and *Listeria monocytogenes*, on in-hull pistachios and hulled floater and sinker pistachios. Reductions of *Salmonella* during pistachio drying were estimated. These data and industry input were used to estimate the impact of delays during the postharvest handling of pistachios. Delays in drying influenced levels of *Salmonella* in floater pistachios and, to a lesser extent, in sinker pistachios. The heat resistance of *Salmonella*, *E. coli* O157:H7, *L. monocytogenes*, and surrogate *Enterococcus faecium* under dry and moist heat conditions was characterized. The data support *Salmonella* as the appropriate target pathogen for pistachios and provide evidence that thermal processes validated for this organism will reduce *E. coli* O157:H7 and *L. monocytogenes* by similar or greater levels. The data support the use of *E. faecium* NRRL 2354 as a surrogate organism for validating thermal processes in reducing *Salmonella* on pistachios.

Poster Session

Evaluation of Falconry as an Economically Viable Co-Management Strategy to Deter Nuisance Birds in Leafy Green Fields: Proof of Concept

Contact

Michele Jay-Russell, University of California, Davis
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Project Date

January 1, 2015 – December 31, 2015

Summary

To test the efficacy of falconry to deter pest birds in leafy greens fields, several trials were performed in spring and fall 2015 in Monterey County, California. The goal was to evaluate nuisance bird attractants, and whether the number of birds decreased in leafy greens blocks during bird abatement treatment using falconry, and whether reductions persisted after falconry. Findings from this proof-of-concept study suggest that falconry is a viable approach to reduce bird intrusions and associated fecal contamination in leafy green fields when large numbers of nuisance birds are present. Season plays an important role in bird abundance, with fall being the most effective time to use falconry for bird control (abatement) in produce fields in the central coast. Additional on-farm studies are needed to determine the effect of using falconry in combination with other nonlethal bird abatement approaches (e.g., audio/visual deterrents) to maximize the cost effectiveness of this approach.

Validating a Physically Heat-Treated Process for Poultry Litter in Industry Settings using the Avirulent *Salmonella* Surrogates or Indicator Microorganisms***

Contact

Xiuping Jiang, Clemson University
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Project Date

January 1, 2016 – December 31, 2017

Summary

Poultry litter has great value as a soil amendment and organic fertilizer for agricultural production. Physical heat treatment is considered one of the most effective methods to reduce or eliminate potential pathogens, such as *Salmonella* spp., in poultry litter. Due to biosafety concerns, it is not feasible to validate thermal processes with pathogenic bacteria in a poultry litter processing facility. One approach for estimating pathogen survival in a processing environment is to monitor the behavior of avirulent *Salmonella* surrogates or indigenous microflora as indicator microorganisms. In this study, potential indigenous indicator microorganisms, including enterococci and total aerobic bacteria, were selected for validating desiccation-adapted *Salmonella* reduction in physically heat-treated poultry litter. Major parameters, including temperature, moisture content, and type of poultry litter, were examined. Our results demonstrated that indigenous enterococci may be used to validate the thermal processing of broiler litter as they accurately mimic the survival behavior of desiccation-adapted *Salmonella* Senftenberg during heat treatment at both 75 and 85°C ($R_2 = 0.87\sim 0.98$).

Poster Session

Evaluation of the Efficacy of Antimicrobial Agents to Prevent the Transfer of *Listeria monocytogenes* from Existing Biofilms to Produce or Processing Surfaces

Contact

Rolf Joerger, University of Delaware
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Project Date

January 1, 2016 – December 31, 2017

Summary

Listeria monocytogenes (*Lm*) is a foodborne pathogen that can cause serious illness and even death in susceptible individuals. *Lm* outbreaks have been associated with fruits, sprouts and vegetable row crops. *Lm* can form or be part of biofilms on produce and surfaces in produce harvesting and processing environments. Once established in a biofilm, *Lm* has highly diminished susceptibility to antimicrobial agents and is difficult to eradicate. Cells surviving in such biofilms can detach and be carried to new surfaces where they can start the formation of a new biofilm or become part of an existing biofilm. It is therefore extremely important to prevent the transfer of cells from existing biofilms to previously uncontaminated surfaces on produce or processing equipment. The proposed study will examine the efficacy of antimicrobial agents to inactivate *Lm* released from existing biofilms and prevent the formation of new *Lm*-containing biofilms on produce and equipment surfaces.

Towards Preventing Internalization and Persistence of Human Bacterial Pathogens in Fresh Produce

Contact

Maeli Melotto, University of California, Davis
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Project Date

January 1, 2015 – December 31, 2015

Summary

Human pathogens can internalize and persist inside crop plants, leading to foodborne outbreaks. Pathogenic bacteria might use natural openings on the plant surface, such as the stomatal pore, to penetrate the leaf interior and colonize the intercellular space. Once internalized, these pathogens often escape current sanitation procedures that are efficient to clean mostly the plant surface. Plants have evolved mechanisms to quickly perceive the presence of bacteria and close the stomatal pores, potentially diminishing leaf contamination. Thus, this project was designed as a proof-of-concept to determine whether: (a) freshly consumed leafy vegetables also employ immune responses towards *Salmonella enterica* serovar Typhimurium SL1344 and *Escherichia coli* O157:H7; and (b) environmental conditions affect these plant responses. We observed the existence of genetic variability among the plant-bacterium interactions studied, which provides an opportunity to breed for plant genotypes that can effectively resist contamination by bacterial pathogens of humans.

Poster Session

The Effect of Soil Remediation Treatments on Microbial Populations Following an Extreme Flooding Event

Contact

Scott Monroe, Purdue University
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Project Date

July 27, 2015 – December 31, 2015

Summary

Flooding may pose a risk of contamination of soils and crops by human pathogens. Crops for human consumption grown in previously flooded areas may be at risk for contamination by foodborne pathogens. In June and July of 2015 the Wabash River flooded a portion of the Southwest Purdue Agricultural Center (SWPAC) near Vincennes, IN. When floodwaters receded, an experiment, consisting of a randomized complete block design with four replications of six treatments, was established in a previously flooded field. Soil samples were periodically collected from experimental plots. Samples were then tested for levels of coliforms, aerobic microbes, and yeasts and molds. Data analysis performed at the conclusion of the experiment suggested that best practice in the case of extreme flooding is to leave soils undisturbed for a period of time following the recession of floodwaters.

Evaluation of Sanitizing Treatments for Sizer Carriers in Stone Fruit Packinghouses***

Contact

Steven Pao, California State University, Fresno
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Project Date

January 1, 2016 – December 31, 2016

Summary

Ensuring safety is a top priority of fresh produce packing operations. This one-year project aims to evaluate and improve sanitizing treatments for sizer carriers in stone fruit packinghouses. The project will not only describe the potential for sizer carriers to harbor pathogens and allow for their growth under different environmental conditions, but will also define a set of sanitizers and application methods that represent the greatest promise for evaluation at the commercial level. Environmental sampling will be performed in active commercial packinghouses to determine natural microbial loads on sizer carriers. Laboratory inoculation studies will be conducted to determine the growth potentials of *Salmonella* and *Listeria* on sizer carriers under varied environmental conditions. The potential of clean-in-place (CIP) sanitization by treating the sizer carriers with no-rinse sanitizers will be investigated. Results from this study potentially will be applicable to diverse fruit packinghouses for preventing pathogen cross contamination in packing operations.

Poster Session

Evaluation of Risk-Based Water Quality Sampling Strategies for the Fresh Produce Industry*

Contact

Channah Rock, The University of Arizona
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Project Date

January 1, 2014 – December 31, 2015

Summary

The quality of irrigation water plays a significant role in the occurrence of outbreaks associated with fresh produce. As a result, FDA Food Safety Modernization Act (FSMA) Produce Safety Rule (PSR), sets guidelines that specify water quality sampling requirements for indicator bacteria (*Escherichia coli*) and sampling frequency. This study aimed to assess and quantify factors relating to the PSR, including the variability of indicator bacteria and pathogens in irrigation water over time, as well as the impact of risk factors (e.g., rainfall, temperature, canal size) on overall water quality. The study led to the development of a risk model for irrigation water quality based on environmental factors. The risk model feeds into a user-friendly app, titled Ag Water, that offers sampling advice and predicts water quality in real-time based on historical data, weather information and environmental parameters.

Control of Cross-Contamination During Field-Pack and Retail Handling of Cantaloupe***

Contact

Laura Strawn, Virginia Tech
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Project Date

January 1, 2016 – December 31, 2017

Summary

Following recent melon-associated foodborne outbreaks, California cantaloupe growers voluntarily developed and implemented commodity-specific food safety guidelines for the safe handling of cantaloupes and other netted melons. While this document details best food safety practices to reduce the risk of contamination during production, packing and distribution, science-based metrics describing the cross-contamination potential of whole melons under typical field-packing conditions is needed (e.g., transfer coefficients for pathogen contamination onto melons during each field-packing step). Furthermore, there is a lack of data on handling practices related to cross-contamination risks for melons in the retail distribution supply chain, as well as guidance on the safe and uniform handling of melons throughout the retail environment. Therefore, this project will identify potential cross-contamination points likely to increase risk and will develop intervention strategies targeted to reduce the occurrence of pathogen transfer events during the handling of melons at harvest and retail.

Poster Session

Remediation and Recovery Measures to Expedite Plant or Replant of Vegetables Following Soil Contamination by *Salmonella enterica**

Contact

Trevor Suslow, University of California, Davis
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Project Date

January 1, 2014 – December 31, 2015

Summary

The aim of this study was to determine a practical strategy that will enhance remediation of *S. enterica*-contaminated soil and prevent subsequent product contamination following replant of leafy greens.

Rapid Tests to Specifically Differentiate Clinically Significant from Environmental STEC Towards Reducing Unnecessary Crop Destruction**

Contact

Trevor Suslow, University of California, Davis
(530) 754-8313, tvsuslow@ucdavis.edu

Project Date

January 1, 2015 – December 31, 2016

Summary

Product testing is often used to pre-screen leafy greens for bacterial pathogens, including Shiga toxin-producing *E. coli* (STEC). Unfortunately, not all testing platforms rapidly distinguish STEC likely to cause illness from those lacking traits necessary for human infection. Due to recognition of diverse STEC in clinical cases associated with diverse foods and environmental sources, many commercial labs have reverted to using detection and, therefore, lot acceptance systems that employ minimal diagnostic markers for this group, presence of *eae* (intimin; attaching and effacing) and *stx* (either of two key forms of Shiga toxin) in an enrichment culture. Presence of these markers by independent cell lines in mixed cultures has resulted in frequent crop destruction and substantial economic loss for individual growers. The anticipated outcome of this proposal is the development of a set of recommendations relative to rapid virulence profiling and its application to routine compliance and lot acceptance testing for fresh produce.



CPS Research Symposium 2015

Poster Session

Comparative Genomics Analysis and Physiological Assessment of the avirulent *Salmonella* Surrogate Relevant to Produce Safety***

Contact

Max Teplitski, University of Florida
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Project Date

January 1, 2016 – December 31, 2017

Summary

Salmonella enterica sv. Newport is recurrently isolated from tomato-associated outbreaks, suggesting that this serovar may have adaptations to proliferate within tomatoes and use them as hosts. Our goal is to characterize *Salmonella* sv. Newport at the functional level and compare its genomic composition with the ubiquitous serovar Typhimurium. Using genome-wide functional analysis we identified that amino acid biosynthesis genes and the global nitrogen regulator glnG are required by *Salmonella* to proliferate within tomatoes, suggesting that nitrogen metabolism plays a major role in the *Salmonella*-tomato interaction. We also identified in *Salmonella* sv. Newport a new hypothetical gene with unknown function required for full fitness within tomatoes. Our results indicate that while most of the genes required for tomato colonization are shared by all the strains, serovar specific adaptations are present.

Food Safety Risks at the Fresh Produce-Animal Interface: Identifying Pathogen Sources and their Movement on Diversified Farms*

Contact

Siddhartha Thakur, North Carolina State University
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Project Date

January 1, 2014 – December 31, 2015 (extended to January 31, 2016)

Summary

The primary goal of this project was to determine the potential transmission of *Salmonella*, Shiga toxin-producing *Escherichia coli* (STEC) O157:H7 and non-O157:H7 STEC from (1) animal operations to vegetable production systems located in close proximity to an experimental research station and (2) to commercial diversified farming operations (Objective 2). Based on the outcomes of a two-year sampling program established in vegetable fields located within 400 feet of poultry or dairy operations, it was established that a 400-foot buffer zone may not be appropriate to prevent pathogen transmission. On commercial diversified farming systems located in Tennessee (n=5) and North Carolina (n=2), STEC was isolated from fresh produce, animal feces, flies and environmental sources in Tennessee while in North Carolina only fecal and soil samples tested positive for these pathogens. The proximity of animal operations to produce fields seems to impact pathogen transfer to produce irrespective of farming operation.

Poster Session

Does *Salmonella* move through the Irrigation Systems of Mixed Produce Farms of the Southeastern United States?

Contact

George Vellidis, University of Georgia
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Project Date

January 1, 2013 – December 31, 2015

Summary

Our previous work has shown that *Salmonella* is present in surface waters used for irrigating produce in the southeastern United States. The goal of this study was to understand whether *Salmonella* moves through irrigation systems and contaminates crops. The project was conducted on produce farms in southern Georgia. We collected samples from irrigation systems and their sources, and analyzed them for *Salmonella* and generic *E. coli*. We also collected and analyzed produce samples from the fields irrigated by these systems. We found *Salmonella* in the irrigation water at about the same rates (30%) as found in the water sources. We also found *Salmonella* on two produce samples, but it is not clear if the samples were contaminated by the irrigation water. We repeated the experiment using in-line chlorination systems to determine if irrigation water can be effectively disinfected. We found a greater than 50% reduction in the number of positive samples collected downstream from chlorination injection points.

Pathogen Physiological State has a Greater Effect on Outcomes of Challenge and Validation Studies than Strain Diversity***

Contact

Martin Wiedmann, Cornell University
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Project Date

January 1, 2016 – December 31, 2017

Summary

Effective control of foodborne pathogens on produce and in produce-associated environments requires science-based validation of interventions and control strategies. It has previously been shown that strains and/or genetic lineages of a pathogen may differ in their ability to survive different stress conditions. Similarly, the physiological state of bacteria, and the conditions under which bacteria are grown, also have a considerable impact on their ability to survive produce relevant interventions. This project will assemble a collection of diverse microbes that are appropriate for validation of pathogen interventions in the produce industry. It will also determine whether and how exposure to different environmental conditions will affect the ability of these organisms to survive stressful conditions and control strategies. The resulting data, along with the bacterial collection developed as part of this project, will facilitate more reliable identification of effective control strategies that can reduce the risk of foodborne illnesses and pathogen contamination.

Poster Session

Methods for Detection of Diverse Parasites on Packaged Salads Based on (Viable) (Oo)cysts***

Contact

Stefan Wuertz, University of California, Davis
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Project Date

January 1, 2016 – March 31, 2017

Summary

Contamination of packaged salads with disease-causing microorganisms constitutes a significant health risk for produce consumers. Protozoan pathogens are targeted because they are implicated in produce-borne illness outbreaks, optimal methods for their detection in produce are lacking, and their prevalence in developed countries such as the United States is likely to rise due to increasing demands for imported vegetables as well as climate variability projections. In order to detect human pathogens on produce in a rapid, accurate and affordable manner, we are developing a simple one-step procedure (multiplex polymerase chain reaction (PCR) to simultaneously detect and differentiate *Cryptosporidium* spp., *Giardia* spp., *Toxoplasma gondii*, and *Cyclospora cayetanesis*. Additional molecular techniques, propidium monoazide quantitative PCR (PMA-qPCR) and reverse transcription (RT)-qPCR will be applied for further quantification of viable protozoan pathogens. Molecular method validation will be performed through laboratory spiking experiments in cooperation with our industrial cooperator.

(*) 2013 RFPs

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(**) 2014 RFP

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