PREHARVEST FOOD SAFETY
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Preface

Assuring the safety of the world’s food supply continues to be a priority, a necessity, and a challenge. The challenges are created by increasing globalization, reductions in trade barriers, and an ever-growing human population that has developed a craving for fresh, diverse foods. Foodborne pathogens may enter the food supply at the preharvest or harvest phases of the farm-to-fork continuum. However, classic control measures and regulations are instituted primarily at the postharvest phase. High-profile outbreaks still occur, from *E. coli* O157:H7 in ground beef and spinach and *Listeria* in cantaloupes to *Salmonella* in tomatoes, affecting morbidity and mortality. The economic impact of foodborne outbreaks is vast, with significant impact on humans, industry, and our society as a whole.

We turned our attention to the work being done to prevent food contamination in the preharvest phase, which has been increasingly recognized as an important step in the food continuum. Preharvest food safety encompasses the measures that are taken to ensure that food products are produced in a safe and wholesome manner on the farm, thereby ensuring an optimally safe commodity all the way to slaughter, packing, and/or processing. Because many enteric pathogens enter the food chain during production, and some can even proliferate during this phase, it is crucial to understand their preharvest ecology and epidemiology in order to identify and evaluate appropriate intervention strategies. Preharvest control measures have expanded and improved, so it is timely to summarize the recent developments and consider the needs and opportunities for the future in the preharvest food realm.

Our goal in creating this book is to provide the scientific community and stakeholders in the food industry with a knowledgeable resource that discusses the developments and challenges of preharvest food safety, focusing on a variety of microbiological hazards in a variety of foods. The chapters in this book address the current state of knowledge and practice, emerging issues, and emerging solutions, with a focus on both research and control measures. A key aspect of the book is the inclusion of multiple food commodities e.g., food animals, produce, grains, and seafood, and the relevant pathogens for each commodity. In so doing, this book will serve as a comprehensive volume that can be used by food safety scientists in general, as well as those focused on a particular commodity. An important objective of this work is to facilitate understanding of the importance of complex
microbial ecology dynamics to preharvest food safety. In the past, little effort was made to undertake an ecological or systems-based approach to understand the broad issues relating to food safety with specific examples, and this book aims to remedy that. Indeed, it is obvious that many of the emerging food safety pathogens or the manifested outbreaks are directly (or indirectly) related to changes in the agri-food systems themselves over the past several decades.

The first section of this book examines the issues associated with preharvest food safety in broad agriculture sectors. We identify major foodborne pathogens of concern for specific products; what is known about the source, prevalence, and transmission of these pathogens in the candidate products; discuss multiple control measures; and identify critical data gaps for the development of future targeted controls. There is information about a vast array of pathogens, including bacteria, viruses, fungi, and protozoa, that are relevant to each of the major commodity types.

In the middle section, we address the emerging issues that impact the preharvest food safety area. We discuss the use of antimicrobials as growth promotants in the food animal industry and its implications. The critical role of the environment, including the potential impact of global climate anomalies on the emergence and transmission of foodborne pathogens, is also highlighted. Finally, we address the growth and challenges of the organic production system. State-of-the-art information on risk assessment, risk management, and emerging preharvest food safety issues in both developed and developing countries is included.

The third and final section aims to provide information on emerging solutions and novel intervention methods that can be employed at the preharvest level to reduce the burden of foodborne pathogens and other potential hazards. We focus not only on the challenges in preharvest food safety, but also on intervention and pathogen reduction strategies, e.g., Good Agricultural Systems, testing, HACCP. We take a holistic approach that treats production agriculture as a system with complex interactions between the environment, the microbe, and the food that are largely driven by ecological considerations and the actions of humans and animals.

This collection will be of use to scientists whose research includes foodborne pathogens, those working in the food industry seeking the latest verified research on food safety, and those interested in our food supply and its environmental impact.

This work required a deep well of knowledge, so sought out and we recruited the very best experts in preharvest food safety to contribute. We are deeply indebted to our many colleagues who worked diligently to write their reviews in spite of their busy schedules. This book would not have been possible without their invaluable input and participation. We also thank ASM Press for being patient with us during this process.

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Siddhartha “Sid” Thakur is a Professor in the College of Veterinary Medicine at North Carolina State University. He is also the Associate Director at the Comparative Medicine Institute where he leads the Emerging and Infectious Diseases Research program. He received his Bachelor of Veterinary Science and Animal Husbandry degree from Govind Ballabh Pant University of Agriculture and Technology (Udham Singh Nagar, India) and his Master’s of Veterinary Science in Veterinary Public Health at the Indian Veterinary Research Institute (Izatnagar, India). He earned his Ph.D. in Population Medicine at the College of Veterinary Medicine, NC State University. Prior to joining the faculty at NC State University, Dr. Thakur was an Oak Ridge Research Fellow at Center for Veterinary Medicine, FDA, Maryland. He espouses the concepts of “One Health” and seeks to understand how antimicrobial resistance develops in “superbugs” that affect animal and human health. He has won numerous awards including the Larry Beuchat Young Researcher Award by the International Association for Food and the International Global Engagement award by NC State. He is currently a NC State Chancellor faculty scholar. Dr. Thakur has authored or co-authored 45 peer-reviewed publications and runs a well-funded extramural research program.
Kalmia “Kali” E. Kniel is Professor of Microbial Food Safety in the Department of Animal and Food Sciences at the University of Delaware. She received her Ph.D. from Virginia Tech in Food Science and Technology with a focus on Food Microbiology. Her doctoral work focused on protozoan parasites. Prior to joining the faculty at the University of Delaware, she was a postdoctoral microbiologist at the USDA Agricultural Research Service’s Animal Parasitic Diseases Laboratory where she worked in the area of food safety and animal health. She is now nationally recognized as a leading expert in transmission of viruses, protozoa, and bacteria in the preharvest environment. Dr. Kniel has been active in researching the mechanisms behind the survival and inactivation of norovirus, hepatitis A virus, and other enteric viruses prevalent in our water and foods. She is an active advocate for teaching food safety at all levels and has been involved with elementary and secondary education. At the University of Delaware, she teaches courses on foodborne outbreak investigations and the basics of food science and food safety to hundreds of students each year.
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