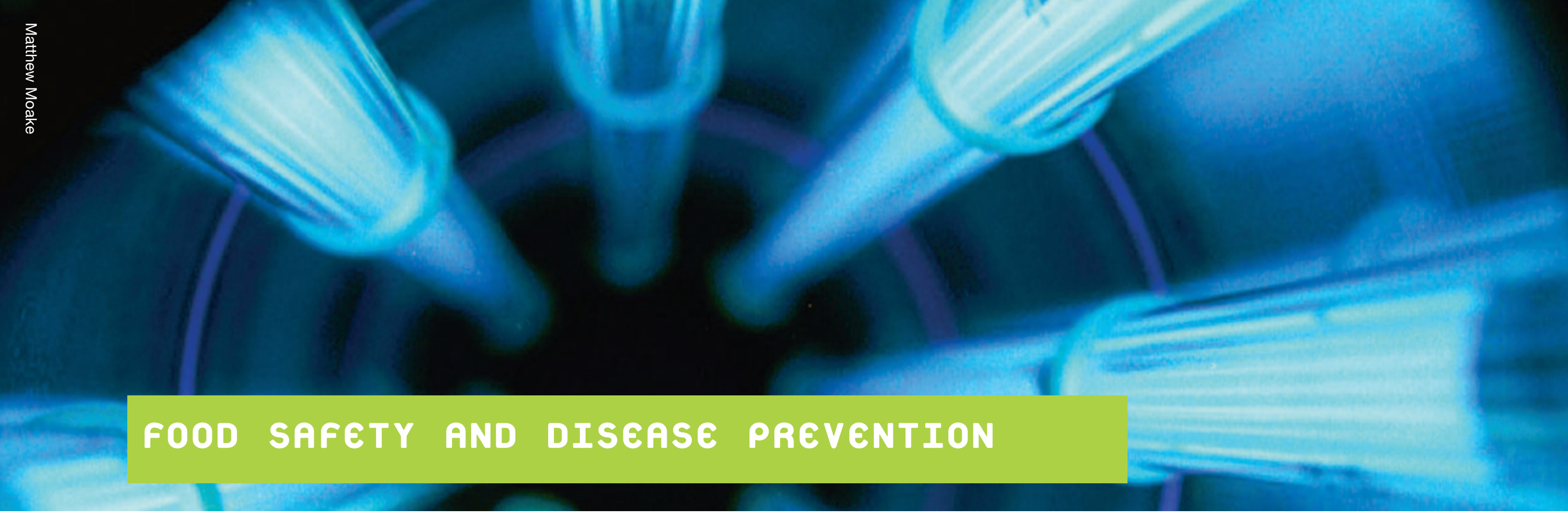

Matthew Moake

FOOD SAFETY AND DISEASE PREVENTION

Cornell Geneva Campus

If during an average lifespan, one eats three meals a day, 365 days a year, for 75 years, then a person has both the gustative opportunities and health risks associated with consuming over 80,000 meals in a lifetime. These meals have the potential of causing illness if not properly prepared.

The food microbiology laboratory of Randy W. Worobo, Food Science and Technology, at Cornell's Geneva campus (Geneva, New York) researches two areas of food safety and disease prevention. Worobo's lab addresses the shortcomings of current food processing techniques. The lab also assesses the potential antidisease activity of naturally occurring food compounds or those produced by potential food-applicable bacteria.

Safe Food-Processing Techniques

The problems of food spoilage and food poisoning became apparent shortly after humanity's conversion from a food-gathering to food-producing society some 10,000 years ago. Since that time, numerous advances in the preparation of food have occurred—the first boiler pots and the fermentation of beer in the Near East in 8000 and 7000 B.C., respectively; the salting of foods near the Dead Sea around 3000 B.C.; the fermentation of sausage around 1500 B.C. in China and Babylon; and canning, freezing, and pasteurization of the postmicrobiology era of food processing. While highly effective at improving the safety and shelf life in dealing with certain types of foods, these methods have proven ineffective for many organisms, such as heat-resistant microbes, or they are inappropriate for various applications, most notably with fresh fruits and vegetables. Recent food science research has aimed to address these gaps in processing methods.

The number of foodborne illnesses associated with the consumption of fresh and minimally processed fruits and vegetables has dramatically increased in the past 30 years. Among these, seed sprouts pose an extreme risk with an average of over one billion bacterial cells/gram present, including potential pathogens such as *Escherichia coli* O157:H7 and *Salmonella* spp, which have caused sprout-associated international disease outbreaks. Traditional surface sanitizers, such as chlorine, have poor efficacy when used for fruits and vegetables, and current thermal inactivation is not feasible due to texture and sensory changes.

As an alternative to these methods, Worobo, along with lab technician John Churey and former Ph.D. student Haijing Hu, have investigated the use of dimethyl dicarbonate as well as extended-duration, low-temperature heat treatments for the control of pathogenic bacteria. These methods successfully reduced sprout pathogenic bacteria levels by over 5-logs without damaging product sensory attributes.

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Along with fresh fruits and vegetables, foodborne illness outbreaks caused by the consumption of unpasteurized juice have also increased during the past decade. Due to the increasing contamination of unpasteurized apple cider with *E. coli* O157:H7, the FDA initiated new regulations for all juice processing, requiring that juice manufacturers either obtain a minimum 5-log reduction of the pertinent pathogen in the finished juice or provide a warning label on the bottle. As an alternative to thermal pasteurization, which cider manufacturers often believe can generate off-flavors in the finished product, Worobo, in collaboration with FPE, Inc., of Macedon, NY, has developed the *CiderSure* series of thin-film UV irradiation machines capable of producing a 5-log reduction in *E. coli* O157:H7, *Cyrptosporidium* oocysts, and other pathogenic microbes. Members of the Worobo group—John Churey, former master's student Nese Basaran, and visiting scientist Armando Quintero-Ramos, University of Chihuahua (Mexico)—continue

Worobo's lab investigated the use of dimethyl dicarbonate and extended-duration, low-temperature heat treatments for the control of pathogenic bacteria. Both methods successfully reduce sprout pathogenic bacteria levels by over 5-logs without damaging product sensory attributes.

Worobo's lab addresses the shortcomings of current food-processing techniques.

Hyungjae Lee, Ph.D. student, works with reverse phase HPLC purification of bioactive peptides produced by bacteria isolated from honey.

Joe Ogrodnick

Melissa Mundo, Ph.D. student, works with DNA amplification of bacteriocin-related DNA regions.

Joe Ogrodnick

John Churey, researcher, works with microbiological analysis of ultraviolet light-treated fluid.

Joe Ogrodnick

Randy Worobo, Food Science and Technology, works with green fluorescent protein expressing pathogen enumeration from survival challenges.

Fred Hickey

Joe Ogrodnick

Randy Worobo

Worobo developed, in collaboration with FPE, Inc. (Macedon, NY), the *CiderSure* series of thin-film UV irradiation machines capable of producing a 5-log reduction in *E.coli* O157:H7, *Cyrptosporidium* oocysts, and other pathogenic microbes.

work to advance the applicability of the machine to other sections of the beverage industry. These units are cost efficient, FDA approved for apple cider, and impart no off-flavors to the final product.

Another concern of the beverage industry is the spoilage of products by heat-resistant microbes, including the bacteria *Alicyclobacillus* spp. and the mold *Byssochlamys fulva*. In the case of these two organisms, both the standard 185-190°F hot-fill and preservatives are ineffective for preventing spoilage. To solve this problem, Worobo's group is searching for novel, bacterially produced antibacterial and antifungal compounds capable of inhibiting a broad spectrum of food spoilage and pathogenic organisms. One such compound well known to the food industry is nisin, a small bacteriocin produced by *Lactococcus lactis* and approved for use in dairy foods within the United States in 1988. Already, lab members Matthew Moake '04 and Haijing Hu have isolated and identified mattacin, a novel peptide antibiotic with a broad inhibition spectrum produced by *Paenabacillus kobensis* MT. Their ongoing work has since sought to characterize the biosynthetic operon for the antibiotic, and through collaboration with John Vederas, University of Alberta, to elucidate the three-dimensional structure for the compound.

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Besides Mattacin, the lab has focused upon searching for novel compounds within food products such as semidry sausage, sourdoughs, and honeys that in theory should suffer from microbial spoilage but in practice do not. Ph.D. students Melissa Mundo and Hyungjae Lee, along with summer undergraduate researcher Darleen Chien '05, have focused extensively on the isolation of antimicrobial compounds from Manuka honey. These honeys show a high level of antimicrobial activity, and already a strain of *Bacillus thuringensis* has been isolated that is capable of inhibiting molds as well as Gram-positive and Gram-negative bacteria. The long-term goal of this research is to identify purified antimicrobial compounds and bacteriocinogenic strains that can be added to fruits, vegetables, and their a ssociated products in order to control foodborne pathogens and spoilage organisms.

Antidisease Properties of Foods

Within recent years, research has begun to uncover the potential health benefits of many types of foods, including the positive effects of naturally occurring phenolics, flavenoids, and organic acids to diseases such as cancer, heart disease, and even Alzheimer's disease. Matthew Moake '04 has investigated the anticancer properties of both bacterial metabolites and fruit, vegetable, and plant polyphenolics in collaboration with Chang Yong Lee, Food Science and Technology, Cornell Geneva Campus. This research has elucidated a number of novel bacterial strains which produce cancer-active compounds, most notably the same *B. thuringenis* strain mentioned above. It has further identified several polyphenolic extracts with potent anticancer activity.

Provided

Matthew Moake '04, undergraduate researcher, worked on solutions for the spoilage of products by heat-resistant microbes, which is of great concern to the beverage industry. Moake is now a graduate student at Johns Hopkins.

Worobo's group takes a multifaceted approach to address the development of safer, healthier foods for the next millennium.

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