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Current focus

Introduction. Microbiological food safety

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Abstract

This current focus covers a broad range of emerging microbiological issues in food safety, from chronic effects of campylobacterosis and bacterial antimicrobial resistance to microbial survival and growth on fresh fruits and vegetables, and advanced technologies for detection and inactivation of foodborne pathogens.

Keywords: Food safety; Foodborne diseases; Food microbiology

For the past decade, the increase in foodborne infections has become an important public health concern worldwide. The epidemiology of microbial foodborne illnesses has changed, not only because of a human population increasingly susceptible to diseases and changing life styles–including more adventurous eating, more convenience foods, and less time devoted to food preparation, but also because of the emergence of newly recognized microbial pathogens and ever-evolving technologies for food production, processing and distribution [1]. The scope of topics covered in this Current focus reflects a broad range of emerging microbiological issues of food-safety significance, from chronic effects of campylobacterosis and bacterial antimicrobial resistance to microbial survival and growth on fresh fruits and vegetables, and advanced technologies for detection and inactivation of foodborne pathogens.

According to a report of the World Health Organization, hundreds of millions of people worldwide suffer from diseases caused by contaminated food (http://www.who.int/archives/inf-pr-1997/en/pr97-58.html). Recent surveillance data from the US Centers for Disease Control and Prevention (CDC) suggest that foodborne diseases cause approximately 76 million illnesses, 325,000 hospitalizations, and 5000 deaths each year in the US alone [2]. Among bacterial pathogens, *Campylobacter* has been the leading cause of foodborne infections, with an estimated 2.4 million cases of campylobacterosis annually in the US, surpassing salmonellosis. More importantly, *Campylobacter* has also been recognized as the most identifiable infection preceding Guillain-Barré Syndrome (GBS), an acute, post-infectious immune-mediated disorder affecting the peripheral nervous system [3]. GBS is now considered the most common form of acute flaccid paralysis in the post-polio era, and induced by not only the biology of *Campylobacter* but also host factors and autoimmunity.

Although most foodborne bacterial infections cause self-limiting diarrhea and do not require antibiotic treatment, systematic infections including bacteremia do occur, particularly in cases involving patients at the extremes of age or those who are immuno-compromised. When infection spreads beyond the intestinal tract, appropriate antimicrobial therapy is deemed necessary and can be lifesaving. As many foodborne pathogens have developed resistance to antimicrobials, treatment of severe foodborne infections may be compromised. In addition to inappropriate use of antimicrobials in humans, a potentially important factor in the development of antibiotic resistance stems from animal husbandry practices, in which antimicrobial agents not only are used for treating and preventing animal diseases, but also are administered at subtherapeutic levels to promote more rapid growth and to improve efficiency of feed conversion into meat. This routine practice may have been a significant driving force in accelerating the emergence of antibiotic-resistant bacteria that subsequently are transferred from animals to humans through the food chain. In fact, antimicrobial resistance has increased dramatically during the last decade among foodborne pathogens including *Salmonella*, *Campylobacter*, Shiga toxin-producing *Escherichia coli*, *Listeria monocytogenes*, and *Yersinia entero*

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colitica [4]. For *Salmonella typhimurium*, a particularly important aspect of this increase has been the widespread dissemination of a multiple-drug-resistant strain of definitive phage type (DT) 104 in food animals since the early 1990s [5]. *Salmonella* and *Campylobacter* have also developed resistance to ciprofloxacin, the drug of choice for enteric infections. Although a considerable amount of scientific information regarding the subject is available, many aspects of the development and dissemination of antimicrobial resistance remain unclear.

Fruits and vegetables are an essential part of the human diet. For the last two decades, human nutrition research has increasingly shown that a well-balanced diet, rich in fruits and vegetables, promotes good health and may reduce the risk of certain diseases. As a result, annual per capita consumption in the US during the 1990s increased by an average of 84 lb (13%) compared to the 1980s. One of the most rapidly growing areas of food processing is fresh-cut produce, such as salads. Despite the benefits derived from eating fruits and vegetables, food safety of fresh fruits and vegetables remains a concern, as these foods eaten raw have long been known to be vehicles for transmitting infectious diseases [6]. The number of confirmed cases of illness associated with raw fruits and vegetables has been relatively low, compared to the number of cases due to consumption of food of animal origin. However, recently a wide range of contaminated fresh fruits and vegetables, as well as unpasteurized fruit juices, have caused large outbreaks of microbial infections. Many pathogenic bacteria, parasites, and viruses have been isolated from raw fruits and vegetables, although spoilage bacteria, yeasts, and molds dominate the microflora on these foods [7]. Survival and growth of human pathogens have been demonstrated on fresh produce. Fresh fruits and vegetables will likely continue to be involved in foodborne illnesses, particularly with a major portion being imported from countries where pathogen contamination of produce frequently occurs.

With the increase in reports of foodborne infections, great attention has been given to the development of methods for detecting microbial pathogens, including culture isolation, serological tests, DNA probes, and PCR assays. Newer technologies such as biosensors and microarray also have been developed for a number of applications ranging from environmental pollutants to foodborne pathogens [8]. Biosensors incorporate a biological sensing element that converts a change in an immediate environment to signals conducive for processing. Two intriguing characteristics of biosensors include a naturally involved selectivity to biological or biologically active analytes and the capacity to respond to analytes in a physiologically relevant manner. However, many challenges still remain in their application to rapid and accurate detection and identification of pathogenic microorganisms. The most important aspect of any biosensor is its molecular recognition component (e.g. antibody, enzyme, nucleic acid, receptor, etc.), for which there is ample opportunity for improvement. Improvements in the affinity, specificity and mass production of molecular recognition components will ultimately determine the success or failure of biosensor detection technologies.

The last defense against foodborne illness is inactivation of pathogenic organisms that are present in food. Thermal pasteurization and sterilization have been predominantly used in the food industry for centuries. However, excessive heat treatment applied by such technologies may cause undesirable sensory changes and loss of nutrients. The use of preservation technologies to inactivate microorganisms in foods without the application of heat, or with the delivery of less heat than would otherwise be necessary, is attractive from the point of view of increasing food product quality. However, new techniques that offer full or partial alternatives to heat and that not only inactivate foodborne microorganisms but also preserve high sensory and nutritional qualities, have been developed in recent years. These include high pressure processing, ionizing radiations, pulsed electric field and ultraviolet radiation. While the mechanisms of action of some of these technologies are well understood at the cellular or molecular levels, understanding of others remains empirical [9].

Along with emerging/evolving microbiological issues in food safety, new technologies have been developed that have contributed to containing the rise in foodborne illnesses. Control and prevention of foodborne diseases can be difficult, as each segment in the production, preparation, and delivery of food must do its part to reduce/eliminate foodborne pathogens. Approaches such as hazard analysis critical control point (HACCP) programs can play an important role in reducing foodborne illnesses. However, solutions to completely eliminate such pathogens from food are complex and not readily available. Changes in the food production environment, food processing with new product formulations, failures in proper food handling practices, and people's interests in eating raw or undercooked foods will continue to promulgate the occurrence of foodborne pathogens in the new millennium. Innovative technologies for pathogen control, from reducing contamination to treating foods to inactivate foodborne pathogens and retain freshness and flavors, are being developed. Such new techniques are crucial to enhancing the safety of the food supply of the future.

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