FOODBORNE PARASITES

FOOD MICROBIOLOGY AND FOOD SAFETY SERIES

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Preface

Microbiologists are being challenged as foodborne outbreaks are increasingly being observed worldwide. Most of these outbreaks are associated with viral and bacterial pathogens such as *Campylobacter*, *Salmonella*, and lately *Escherichia coli* O157:H7, which emerged in the 1990s. The role of food in transmission of parasites was not studied until later.

Although parasites have been evolving with man since antiquity, the control and eradication of these diseases is still far from being achieved and they are more frequently being reported in the literature as causative agents of food and waterborne illnesses.

Parasites have been consistently reported in developing and endemic countries. However, the presence of these parasites in the developed world has increased in the past two decades. For example, in the United States alone, foodborne outbreaks have multiplied by more than a factor of eight during the past 15 years.

Many factors can be attributed to the rise in parasitic foodborne outbreaks. The increase of international travel and population migration encourages rapid disease dissemination. Globalization of the food supply has introduced new challenges in the U.S. food safety arena. The food habits of Americans are changing, resulting in fresh foods and vegetables being consumed. Consequently, importation of foods is now necessary in order to satisfy the consumer demands for a year-round supply of certain commodities, such as exotic fruits and vegetables. Importations have also increased as the costs of particular products have been reduced. Unfortunately, transportation conditions such as controlled refrigeration favor survival of parasites on fruits and vegetables. In addition, restaurants presenting ethnic foods not traditionally consumed are revealing public health issues that have not been considered. For example, *Sarcocystis*, a nematode parasite, has been identified in meats served at Arab restaurants in Brazil where meats are consumed raw.

Moreover, populations are at increased risk for acquiring infection and developing gastrointestinal illness due to the prevalence of asymptomatic carriers and the zoonotic potential of some parasites that contribute to the spread of the pathogen. For example, inadequate composting and lack of agricultural practices has contributed to the exposure of food products to animal waste and hence, parasites.

Medical advances have contributed to changes in the US demographics, yet, the elderly, immunocompromised individuals and children are susceptible populations to parasitic infections.

Misdiagnosis of parasitic infections is not uncommon. Diagnostic laboratories and medical personnel may not be familiar with parasite identification and the risk factors for acquiring these infections. Excretion of parasites is intermittent, requiring that more than one stool sample be examined. In some instances, special staining procedures not routinely requested by medical personnel are required to identify parasites properly.

Outbreak investigations may take many days, by which time samples of the implicated product may not be available for investigation. Therefore, food scientists and the medical community need to be aware of the role of parasites as significant agents of foodborne outbreaks. Routine examination of clinical specimens of individuals with gastrointestinal illness does not search for parasites. In fact, testing for *Cyclospora* and *Cryptosporidium* must be specifically requested. Improvements in detection systems not only in the clinical settings, but also in the food microbiology laboratories have allowed for identification of infections that previously went undetected.

Molecular assays have been very helpful in foodborne outbreak investigations but are limited by isolation procedures for the parasites. Recovery is particularly important since parasites are generally inert in the environment, and enrichment procedures applied to bacterial contaminants are not an option.

In the 1980s, *Cryptosporidium* emerged as a significant pathogen responsible for high mortality in immunocompromised patients; particularly in those with AIDS. Although to date there is no effective therapy for cryptosporidiosis, a great deal of information was learned about this parasite, most notably that the cellular immune response plays a significant role in eradication. *Cyclospora*, another emerging parasite, has also proven to be a challenge to work with and has demonstrated to be highly resistant to environmental conditions. *Cyclospora* is a parasite that is associated with foodborne outbreaks in the United States and is caused by contaminated produce imported for human consumption. *Trichinella*, a nematode, is another emerging pathogen that is frequently reported in the United States and is commonly associated with the ingestion of game meats and sausages that are not properly cooked.

This book will review the two major parasite groups that are transmitted via water or foods: the protozoa, which are single celled organisms and the helminths. The helminths are classified into three sub groups, the cestodes (tapeworms), nematodes (round worms), and trematodes (flukes). To better understand their significance, each chapter will be covering the biology, mechanisms of pathogenesis, epidemiology, treatment, and inactivation of these parasites. A better understanding of the biology and control of parasitic infections is necessary to reduce and eliminate outbreaks in the United States and elsewhere.

PROTOZOA

Protozoa are single-celled organisms. They are eukaryotes which have compartmentalized organelles and the infectious stages are environmentally resistant. Protozoa can be blood borne or transmitted via a vector, such as a mosquito. The most well-known disease in this group is malaria. Other protozoa, acquired via water, are environmentally resistant, and can be responsible for worldwide human illness. A classic example of this group is *Cryptosporidium*. As we learn more of the molecular composition of these parasites, and the development of molecular tools for genotyping, new species are being described. Along with these, a reevaluation of these species and their significance in public health is changing. This is particularly true

in the case of *Cryptosporidium*. The species *C. parvum* was considered to be unique, although there was significant evidence that the clinical presentation was variable as well as host susceptible. Now more genotypes are being identified in human and animal species. Although most of the outbreaks associated with *Cryptosporidium* have been waterborne, a few reports have been foodborne. The contamination has been associated with food preparation practices, hygienic conditions of the food handlers, or by fresh produce that may have been contaminated on the farms.

Most parasites are obligate intracellular organisms. In contrast with bacteria, parasites are inert and do not multiply in the environment. Therefore, studies of food matrices and determination of the safety of some products is challenging. Isolation and detection procedures are crucial because an enrichment process for parasites is not available. Although molecular assays overcome these difficulties, specific limitations of each organism will be discussed in the pertinent chapters.

Other protozoa can be acquired by more than one route. *Toxoplasma* is a good example of this group. Present in almost every region of the world, *Toxoplasma* can be acquired by most warm-blooded animals, by ingestion of oocyst (the environmentally resistant form) in water or fresh produce, or by ingestion of raw or inadequately cooked meats which contain tissue cysts of the parasite.

Most of the foodborne protozoa cause diarrheal illness in humans; however, *Toxoplasma* can have detrimental consequences for the fetus of pregnant women and in immunocompromised individuals. In immunocompetent individuals toxoplasmosis may be asymptomatic, but if the immune competency diminishes either by chemotherapy or by acquired deficiency, the individual can present symptomatic toxoplasmosis that is most commonly manifested as encephalitis.

HELMINTHS

This group is commonly identified as worms and is rapidly emerging in the United States and worldwide. Ingestion of raw or improperly cooked meats may be the source of infection with most of these parasites.

Helminths have very complex life cycles and in most instances humans are accidental hosts. However, in other cases the adult worms can find a home in the human body, start reproducing and shed eggs in the environment. These eggs could infect other susceptible individuals.

Adult nematodes, present as male and female worms, can be found in the gut of the infected individual. In contrast, cestodes and trematodes can be hermaphrodites and self fertilize their eggs; therefore, most of them do not require a male and female worm to complete their life cycle.

Some infections with helminths have been associated with immigrant populations that initiate an outbreak or start developing clinical signs infrequently observed by medical personnel. An example of this is cysticercosis. Outbreaks in the United States were described in an ethnic group that did not consume pork, and further investigation showed that infection was initiated by a foreign housekeeper who had teniasis.

Trematoda can also be acquired by ingestion of raw or undercooked fish. Although freezing can inactivate the cysts, the larval stages can remain viable at refrigeration temperatures. Many consumers prefer fresh fish due to the detrimental textural changes in the fish after freezing.

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