

Risk Factors of Food-Borne Bacterial Diseases in Ramadan

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ARTICLE INFO	ABSTRACT
<p><i>Article type:</i> Original article</p> <hr/> <p><i>Article History:</i> Received: 04 Dec 2017 Accepted: 23 Dec 2017 Published: 5 March 2018</p> <hr/> <p><i>Keywords:</i> Bacteria Fasting Food-borne Pathogens Food Safety Ramadan</p>	<p>Introduction: In the holy month of Ramadan, Muslims abstain from eating and drinking during daytime and mostly take two meals per day. One of these major meals is consumed before sunrise (Sahur), and the other is taken after sunset (Iftar). The partial nutritional deprivation in Ramadan may affect the immune system, while the other rituals of this month might render fasting individuals susceptible to various pathological conditions, such as food-borne infections. The present study aimed to evaluate the risk factors of food-borne bacterial diseases in Ramadan.</p> <p>Methods: A comprehensive search was performed via databases such as Google Scholar and PubMed to identify the titles and abstracts of the relevant articles using specific terms regarding food safety issues, Ramadan, and fasting.</p> <p>Results: The major risk factors associated with the occurrence of food-borne diseases during Ramadan were inappropriate storage and handling of cooked food products, in-advance preparation of meals, and nutritional deficiency.</p> <p>Conclusion: According to the results, prevention of food-borne infections during Ramadan requires critical measures, such as the provision of high-quality food ingredients, improving personal hygiene, and cooking and storing of food products at proper temperatures.</p>

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Introduction

Nutritional deprivation could suppress the function of the immune system (1); therefore, provision of high-quality, healthy nutrients is of paramount importance in such cases.

The holy month of Ramadan lasts for 29-30 days in the Islamic calendar. During this months, Muslims refrain from eating and drinking in daytime hours (2) and mostly take two meals per day. One of these major meals is consumed before sunrise (Sahur), and the other is taken after sunset (Iftar). All healthy, adult Muslims (about 800 millions) are obligated to follow the rules of fasting during the holy month of Ramadan. Since Ramadan coincides with different seasons of year, the duration of daytime hours and fasting may vary

accordingly (3).

Fasting individuals are susceptible to partial nutritional deprivation, especially in the long summer days, which could adversely affect their immune system. In this regard, mild pathological conditions have been shown to compromise the health status of fasting individuals in Ramadan. Among these conditions, food-borne diseases account for an important group of illnesses occurring worldwide, the symptoms of which may vary from mild gastrointestinal discomfort to severe neurological signs and even death. Individuals with immune system deficiency are particularly susceptible to food-borne infections. According to the literature,

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nutritional deficiency is one of the major contributing factors to immunodeficiency disorders; such examples are poor nutrition and starvation (4).

The present study aimed to evaluate the main food safety risk factors in the holy month of Ramadan, focusing on food-borne bacterial pathogens, in order to describe the most effective strategies to prevent food-borne diseases.

Material and methods

A comprehensive search was conducted via databases such as Google Scholar and PubMed in order to identify the titles and abstracts of the relevant articles using keywords such as 'fasting' or 'Ramadan' and 'food safety' or 'food-borne diseases'. The outcome revealed that approximately only one paper was focused on the food safety issues during Ramadan (5). Additionally, the other retrieved reports and data concerning the research question have been reviewed in the Results and Discussion section of the paper.

Results and Discussion

Food-borne Diseases and the Susceptible Groups

Each year, food-borne infections affect a significant number of people worldwide, some of whom die or are hospitalized in healthcare centers. However, due to the non-specific and occasionally mild symptoms of food-borne diseases, the estimations of the number of the infected patients are mostly inaccurate, especially in developing countries and including Muslims nations, where there is often the lack of a system for the collection and report of the data on the incidence of food-borne diseases. According to statistics, the ratio of the reported cases to the actual cases of food-borne diseases is 1:25 and 1:100 (6), while higher ratios have also been confirmed by other researchers, as Lund et al. estimated the ratio at 1:300-350 (7).

Reports suggest that the annual patient-related cost for the treatment of bacterial and parasitic food-borne diseases is 6.5 billion dollars or more in the United States (8). Considering the massive expenditure of food industries, food poisoning outbreaks may lead to significant problems, such as bankruptcy.

Although other food companies may not be directly involved, the issue could be equally detrimental since the implementation of food safety assurance systems in these establishments is highly costly.

Various types of food-borne pathogenic agents could cause food-related diseases, among which bacterial infections are known to be most prevalent (6). Evidence suggests that the risk of illnesses as a consequence of microbial food contamination is 100,000 times higher than the risk of pesticide food contamination (6). The foremost known food-borne pathogens include *Salmonella*, *Escherichia coli* O157:H7, *Campylobacter*, and *Listeria*, which are associated with significant hospitalization, mortality, and morbidity (8).

Some individuals are highly susceptible to various food-borne pathogens. In the United States, approximately 20% of the population are considered high-risk for the severe consequences of food-borne illnesses (9). In general, immune system suppression is the key contributing factor to the increases susceptibility in this regard, which may arise due to diseases, pregnancy or old age. In such cases, even a low number of food-borne pathogens could trigger severe conditions. In a study by Lund et al. (2011), the susceptible individuals to major food-borne pathogens have been thoroughly discussed (4).

In general, high-risk individuals to food-borne diseases are classified into six major categories, including those with pathological or iatrogenic immunosuppression, patients receiving the immunosuppressant therapies that may increase the risk of food-borne diseases, individuals with the acquired immune deficiency syndrome, those with deficient iron metabolism, cirrhosis or other hepatic diseases, patients with the physiological impairment of the immune system, and individuals suffering from impaired physical barriers against food-borne infections. Among these categories, patients with malnourishment (physiological impairment of the immune system) are believed to be the most susceptible group to these infection (10). By definition, malnutrition refers to the deficiencies in both micronutrients and macronutrients. In addition to low-income countries, the condition is likely to occur in the other parts of the world as well (4, 11).

Major Pathogens Associated with the Incidence of Food-borne Diseases in the Individuals with Deficient Immune System

Food-borne pathogens are classified into three main categories, including bacteria, viruses, and parasites. According to reports, most food-borne diseases are caused by pathogenic bacteria. The six major food-borne bacterial genera are *Escherichia*, *Campylobacter*, *Salmonella*, *Listeria*, *Clostridium*, and *Staphylococcus*, the adverse effects of which are more significant in immunocompromised individuals compared to the other pathogens.

Salmonella are among the most commonly isolated food-borne pathogens worldwide. It has been estimated that annually 93.8 million food-borne diseases and 155,000 deaths are directly caused by *Salmonella* infections (12). Most *Salmonella* infections in human hosts are associated with *Salmonella enterica* subspecies enterica. The most frequent symptom of *Salmonella* infection is gastroenteritis, followed by bacteremia and enteric fever (13). These bacteria are mainly isolated from dairy products, poultry, and eggs (14).

Non-typhoid *Salmonella* strains are known to cause gastroenteritis symptoms. The most susceptible populations to the infections caused by these strains are the elderly, children aged less than five years, and immunosuppressed individuals (15). Moreover, the aforementioned groups are at a higher risk of becoming a chronic carrier of *Salmonella* infections (16).

Ingesting a high number of some *E. coli* strains (enteropathogenic) may lead to gastrointestinal diseases (17). Due to the poor hygiene observance in low-income countries, the risk of *E. coli* infections is comparatively higher in these regions. *E. coli* strains are considered to be food-borne enteric pathogens isolated from dairy products (e.g., cheese), which have been associated with the related infections and diseases (17). Furthermore, there have been reports on the mortality caused by the virulent strains of *E. coli* (O157:H7) mostly among children and elderly individuals (18).

Campylobacter is known as a leading food-borne bacterial pathogen, which mostly causes diarrheal disease (14). In the United States, it has been estimated that more than two million

diseases, 13,000 hospitalizations, and more than 100 deaths annually occur due to *Campylobacter* infections (14). The majority of the reports on campylobacteriosis have denoted the consumption of contaminated poultry meat, raw milk, and water as the main risk factors of this bacterial infection (14). Immune function of the host and age have been considered as the main influential factors in the occurrence of *Campylobacter* infections, and acute campylobacteriosis outbreaks have specifically been noted among the elderly, children, and immunosuppressed individuals (19-21).

Listeria (*Listeria monocytogenes*) is a ubiquitous food-borne pathogen, which could cause a severe condition known as listeriosis, particularly in the elderly, pregnant women, and individuals with deficient immune system (22). *Listeria* infections are associated with a higher rate of mortality compared to the other food-borne pathogens. According to the reports in this regard, food-borne listeriosis may lead to death in 20-30% of the susceptible individuals (23). Moreover, adults with impaired immunity to infections are more prone to septicemia and meningitis compared to the other individuals (23).

Several reports have confirmed the significant association between the incidence of the food-borne diseases caused by other pathogens and the human hosts with immune system deficiency (4). Conditions that enhance iron availability in the human body (e.g., individuals with deficient iron metabolism, cirrhosis or other hepatic diseases) could stimulate the growth of various food-borne pathogens, such as *Clostridia*, *Bacillus*, and *Vibrio* (24, 25).

Diarrhea could act as a defensive mechanism via the elimination of enteropathogens. Inhibition of diarrhea has been shown to increase the severity of the associated infections; for instance, a severe case of enteritis and two deaths were reported in an outbreak of *Clostridium perfringens* in the United States (26). Deficient immune system in neonates has been shown to be a significant predisposing factor for the germination and colonization of *Clostridium botulinum* spores, which may eventually lead to infant botulism (4).

Risk Factors Associated with Food-borne Diseases in Ramadan

Given the importance of food-borne disease outbreaks, there has been extensive research yielding valuable data on the most common risk factors associated with food safety issues. In this regard, five main contributing factors have been mentioned in the literature, including the in-advance preparation of meals, preservation of foods at an ambient temperature, improper cooling of the meals, using contaminated processed food products, and improper cooking temperature (6).

Among various foodstuffs, animal-derived products (e.g., meat, milk, poultry and eggs) are most repeatedly implicated in association with food-borne diseases in industrialized countries. In Muslim communities, families often gather in the holy month of Ramadan for Iftar and Sahur feasts, and in some cases, these gatherings are held for larger groups in public places, such as mosques. It has been well described that due to the higher possibility of food-borne pathogen transmission, inappropriate storage conditions and poor food handling while holding community events, such as fundraisers, wedding ceremonies, and dinners, the risk of food-borne disease outbreaks tend to be higher (27,28). Furthermore, preparation of Sahur meals in advance (between Iftar and Sahur) is a common practice in Muslims families, as a result of which the prepared foods are sometimes stored at an ambient temperature until consumed at Sahur. This is considered to be a major predisposing factor for the occurrence of pathogenic infections, particularly in the case of in-advance preparation of the meals, preservation at an ambient temperature, and improper cooling of the prepared foods.

Numerous reports have discussed the impact of mishandling and inappropriate food storage on the incidence of the food-borne diseases caused by various pathogens, such as *Clostridium perfringens* (29,30), *Bacillus cereus* (31), *Staphylococcus aureus* (32), *Salmonella* (33), *Campylobacter jejuni* (6), and *E. coli* (17). As mentioned earlier, partial nutritional deprivation during Ramadan may deteriorate the function of the immune system in fasting individuals, thereby intensifying the diseases caused by the aforementioned pathogens. This issue is more pronounced in the case of diabetic

fasting individuals who are more susceptible to certain food-borne pathogens, such as *Listeria monocytogenes* and *Vibrio vulnificus* (6).

Prevention of Food-borne Diseases in Ramadan

Prevention of food-borne infections is a multifactorial process demanding the thorough control of the entire food supply chain. Evidently, the first step in this process involves preventing the entry of pathogens into the food ingredients. The following steps involve the prevention of further contamination during the post-production phase and post-harvest handling. In addition, it is recommended that effective controlling processes be implemented to inhibit the growth of food-borne pathogens if necessary. The first step is often unrelated to consumers and mostly involves the food producers and food control organizations, who are responsible for the safety of the food ingredients.

Some recommendations have been proposed by several authors regarding the control of the risk factors associated with food-borne diseases at home and in community events (5, 34). Proper food storage and cooking, prevention of cross contamination, and observance of personal hygiene are among the main factors that have been approved by food safety specialists, which play a pivotal role in the control of food-borne diseases.

Time and temperature abuse in the storage of prepared Sahur and Iftar meals is considered to be the main food safety risk factor during Ramadan. Therefore, special attention must be paid to the control of storage temperatures (e.g., cooling temperature), serving, and preparation of the prepared foods. Furthermore, food ingredients should be supplied from reputable sellers, and the transportation and storage of different types of raw meat should be carried out separately from ready-to-eat food products.

Perishable food products must be kept out of the 40-140°F danger zone (35) and should be exposed to the minimum internal temperature of approximately 165°F while cooking. It is highly recommended that hot foods (e.g., prepared Sahur) be cooled down to 40°F immediately after cooking and thoroughly reheated to an internal temperature of 165°F

before consumption. Additionally, the individuals who are in charge of food preparation are required to wash their hands and the cooking utensils with soap and hot water prior to preparing any food items.

Conclusion

The rituals in the holy month of Ramadan create special conditions that may increase the risk of various food-borne diseases. In the current research, we described the major influential factors in the occurrence of food-borne diseases in Ramadan. According to the results, some of the main risk factors in this regard include the in-advance preparation of meals, improper handling and storage of cooked foods, and partial nutritional deficiency during Ramadan. Therefore, it is recommended that critical measures be taken in order to prevent food-borne diseases in this month, such as the provision of high-quality food ingredients, improving personal hygiene, and cooking and storing of foods at proper temperatures.

Conflict of interest

The authors declare that there are no conflicts of interest.

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