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Mini Review

Foodborne Illness

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Abstract

Public health and food safety have immense attention over the past decade. Food poisoning may caused by two factors such as food infection and food intoxication. Food infection refers to the presence of bacteria or other microbes, which infect the body after consumption. Food intoxication however involves the ingestion of toxins including bacterially produced exotoxins present within the food even when the microbe that produced the toxins is not present in the food. Presence of pathogenic microorganisms/toxins in food is of main concern especially for food industries that may cause serious public health hazard. The pathogens which enter the host's body through contaminated food, which has been improperly processed under unhygienic conditions or stored in improper conditions, are called as food borne pathogens. Irrespective of overall improvement in food safety issues, many countries report outbreaks of food poisoning due to microbial contamination and their toxins. According to WHO estimation, in 2017, diarrhoeal disease is the second leading cause of death in children under five years old kills around 525 000 children under five.

Keywords: Food; Public health; Toxins

Introduction

2005 alone 1.8 million people died from diarrheal diseases caused by contaminated food and drinking water (WHO, 2007) [1,2]. As per Centers for Disease Control and Prevention (CDC, 2011) [3] USA alone reports around 48 million cases of food borne diseases, resulting in 128,000 hospitalizations and ~3,000 deaths each year.

The virulence factor in a microorganism determines the degree of pathogenicity, which may be its genetic, biochemical or structural features. The virulence factor may be protein-based toxins, enzymes, capsules, flagella, fimbriae or pilli etc. The most common food borne pathogens are *Escherichia coli* O157:H7, some strains of *Staphylococcus aureus, Shigella spp, Bacillus anthracis, Campylobacter jejuni, Clostridium perfringens, Clostridium botulinum, Salmonella spp., Listeria monocytogenes, Vibrio cholerae, Yersinia enterocolitica, Coxiella burnetii* etc [5,6].

Microbial toxins from foodborne pathogens are the leading cause of food intoxication all over the world. The presence of microbial toxins may lead to food intoxication by mycotoxins, exotoxins and enterotoxins. In general, bacterial toxins are of two types. The structural components of the bacteria such as lipopolysaccharide complex released inside the host tissue because of bacterial cell lysis are called endotoxins [6]. Pathogenic bacteria also secrete certain protein based toxin termed as an exotoxin that generally disrupts the normal cellular metabolism. Enterotoxins are chromosomally encoded exotoxins secreted by pathogenic bacteria, which are often water soluble, heat stable and low molecular weight compounds. They generally disrupt the cellular permeability by creating electrolyte imbalance in the cell. Hence, clinical diagnosis, water, food safety and environmental analysis are some of the areas where detection of microbial pathogens is crucial [7].

Staphylococcal food poisoning

Staphylococcus aureus (S. aureus) is one of the major foodborne pathogens that have drawn attention due to toxin-mediated virulence, invasiveness and antibiotic resistance. Almost 30% to 50% of healthy human populations are carriers of *S. aureus* in their anterior of the nose [8,9]. This might be a risk factor for infection and transmission in hospitals. *Staphylococcal* Food Poisoning (SFP) being very common across the world, is ranked second or third (9.8%) most common causative agent of foodborne illness [10,2]. SFPs are most prevalent in seafood, meat products and dairy products. They have been reported mainly from American, European and East Asian countries. Even in Indian subcontinent reports of food poisoning are very frequent. An outbreak of SFP was reported by Nema et al. [11,12] in the state of Madhya Pradesh (India) that occurred during April 2005 after the consumption of a snack called "Bhalla" made up of potato balls fried in vegetable oil. As a result, more than 100 children and adults were suffered from the typical symptoms of SFP and hospitalized. *S.aureus* producing a combination of *Staphylococcal* Enterotoxin B (SEB) and *Staphylococcal* Enterotoxin D (SED) was reported as causative agent of the outbreak. In 2000, Japan has reported an extensive staphylococcal outbreak occurred in Kansai district affecting as many as 13,420 people [13]. In 2009, it was 7.6% out of 536 bacterial food poisoning outbreaks recorded in Japan as per the statistics published by Ministry of Health, Labour and Welfare (Food Safety Division, the Ministry of Health, Labour and Welfare, Japan, 2009). A massive *staphylococcal* food poisoning incident was reported in Brazil during 2004 affecting about 4,000 patients [14]. In European Union, *S. aureus* was the fourth (5.5%) most common causative agent for the reported foodborne outbreaks in 2008 according to European Food Safety Authority reports [15]. Chi Thuong et al. [16] have reported that community-acquired methicillin-resistant Staphylococcus aureus (CA-MRSA) are responsible for 15-74% of skin and soft-tissue infections among patients admitted to emergency departments in the USA. They have investigated an outbreak of severe CA-MRSA infections in children following out-patient vaccination during 2006 with proper approval by the health service of Ho Chi Minh City,

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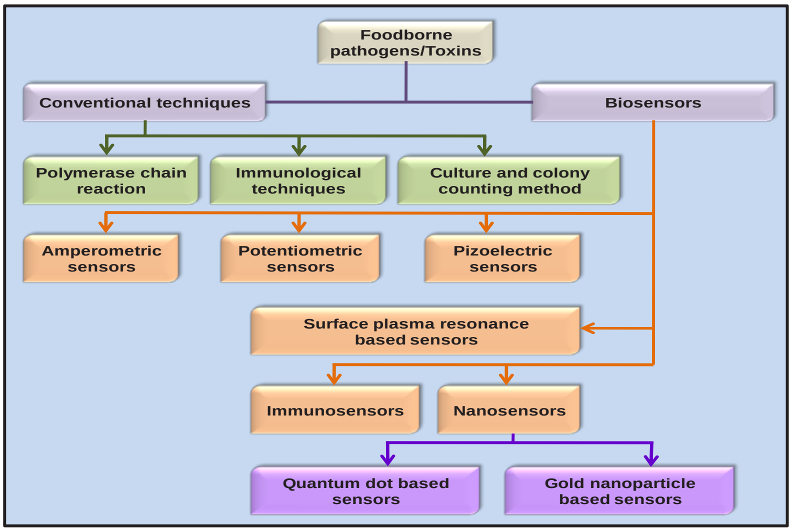

Figure 1: Schematic representation for foodborne pathogen detection.

Vietnam. After thorough reviewing of clinical data, they concluded that CA-MRSA was transmitted in children by an asymptomatic colonized health care worker during immunization injection. Identical strains from children and health care worker supported the fact that outbreak may occur due to insufficient infection control practices. However, foodborne illness can result in permanent health problems or even death, especially for people at high risk, including babies, young children, pregnant women (and their fetus), elderly people, sick people and others with weak immune systems [6].

Recently, Smith and Fratamico [17] have reported that serious food borne pathogens are emerging due to many aspects of food processing and use of antibiotics. Livestock such as cattle are known to carry many infectious diseases. The fear of livestock falling sick is prevalent in all nations and therefore, farmers hesitate to increase their livestock. Some of the health related issues in livestock are

1. Health and safety: Highly nutritious Bovine milk is contaminated with Leukotoxins due to mastitis infection. Even in low concentration this toxin severely affects human immune system. Therefore detection of Leukotoxins in milk is essential for animal as well as human health (Padmaja et al.) [18].

2. Losses due to bovine mastitis: Mastitis is one of the costly diseases in dairy animals, which can cause severe losses to the dairy industry. It reduces the milk yield, deteriorates its quality, thereby limiting its consumption and shortens the productive life of affected cows. The economic impact of mastitis was assessed by calculating production loss (milk yield loss and discarded milk) during mastitis, post treatment milk yield loss which normally lasts for 30 days. This amounts to total economic loss of Rs. 7824/- per month per cow and Rs 600 billion per month for the country (India).

Detection of pathogens and toxins

To minimize the potential health and economic impacts of foodborne pathogens, it is necessary to have rapid, selective and specific detection methods (Figure 1). The traditional methods used for their detection are Polymerase Chain Reaction (PCR) [19], culture and colony counting [20], immunological techniques [21] and fluorescence based assays using organic dye molecules [22]. These conventional techniques require skilled personnel, time consuming to perform analyses and are laborious. Conventional pathogen detection methods lag behind the analytical techniques when detection time is concerned. Organic fluorescent dyes are commonly used for fluorescent assays for detection of pathogens/ toxins. They suffer with susceptibility for photo-bleaching effects and show spectral overlap that make them unsuitable for multiplexed analysis. Therefore, the need exists for the development of novel strategies and techniques, which are fast, reliable and highly sensitive for monitoring food toxicants. In this regard, QD based biosensor systems could be an alternative integrated technique possessing high specificity of biological reactions with magnetic and optical behavior of QDs. Biosensor devices are emerging as one of the relevant tools for food and environmental safety measures [23,24]. Biosensors are the preferred choice of interest over conventional techniques due to their specificity, rapidity, ease for mass fabrication and field applicability [24]. Recent developments in material science and nanotechnology have increased the capability of biosensing technologies in food and environmental monitoring.

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