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REVIEW

Rapid testing methods for food contaminants and toxicants

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Abstract

Food safety is one of the major concerns in every country regardless of the economic and social development. The frequent occurrence of food scandals in the world has led the Chinese government to implement several strategies to fortify the food supply system to a high food safety standard. This relies heavily on laboratory testing services but conventional methods for detection of food contaminants and toxicants are limited by sophisticated sample preparation procedures, long analysis time, large instruments and professional personnel to meet the increasing demands. In this review, we have incorporated most of the current and potential rapid detection methods for many notorious food contaminants and toxicants including microbial agents, toxic ions, pesticides, veterinary drugs and preservatives, as well as detection of genetically modified food genes and adulterated edible oil. Development of rapid, accurate, easy-to-use and affordable testing methods could urge food handlers and the public to actively screen for food contaminants and toxicants instead of passively relying on monitoring by the government examination facility. This review also provides several recommendations including how to encourage the public to engage in the food safety management system and provide optimal education and financial assistance that may improve the current Chinese food safety control system.

Keywords: rapid testing, food contaminants and toxins, microbial agents, pesticides, veterinary drugs, preservatives, formaldehyde, nitrite, nitrate, test strips

1. Introduction

China has the highest population with approximately 1.37 billion people accounting for 19% of the world population, yet it only has approximately 11.3% of the world arable lands (NBSC 2014). To cope with increasing food demand, the Chinese government has implemented several strategies such as increasing the number of agriculture equipment, the use of fertilizers to ameliorate the overuse of arable lands, breeding of high-yield cereals and investing on researches on genetically modified (GM) food. Food safety is always a major concern for every country and China is no exception. Over the past two decades, China has turned its attention from food supply to food safety owing to the frequent occurrence of international food incidents such as the *Salmonella* outbreak, the use of horsemeat in burger, the illegal use of phthalates as a clouding agent, the contamination of formula milk by melamine, the meat scandal of Shanghai Husi Food Company which sold reprocessed

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stale meat to many fast food chains and restaurants including McDonald's, Burger King, and KFC across the world, Sudan dyes found in eggs and recycling of gutter oil (He *et al.* 2007; TFDA 2011; EC 2013; CDC 2014; Elisângela *et al.* 2014; Lu and Wu 2014; The Lancet 2014). In view of the food incidents occurred around the world, China has been making tremendous efforts to ensure food safety since the passing of the Provisional Food Hygiene Ordinance in 1965 (Jia and Jukes 2013). This ordinance was amended into the complete *Food Hygiene Law of China* in 1995 . In 2003, the *Agriculture Law of China* was passed to implement quality standard, inspection and supervision systems for agricultural products. Recently, there were the passing of the *Agricultural Product Quality and Safety Law of China* in 2006, the *Food Safety Law of China* in 2009, the establishment of China Food and Drug Administration in 2013 and the announcement of the new 12th Five Year Plan on National Food Safety Control Systems (State Council of China 2012). The food safety quality system in China has already been greatly improved but a few of the implementations of the monitoring and surveillance system are still far behind the developed countries. The food scandals have disclosed the importance of developing a comprehensive monitoring and surveillance system that not only focuses on the food end products but the whole food supply chain. The monitoring and surveillance system must cover all the different parts of the food supply chain, from the agricultural production, food processing and storage, to the import, export and consumption of food in order to provide a food chain transparency and risk management for the government and public (Fig. 1). This monitoring and surveillance system has been applied compulsorily by the governments and major companies in the EU, the US, Japan and other countries (Mol 2014). One difficulty to uphold the high safety standards through the monitoring and surveillance system in China attributes to the large number of small enterprises in food-related industries (Lam *et al.* 2013). These enterprises have fewer than ten employees and together they make up less than 10% of the market share of food supply in China (UNRCC 2008). A thorough monitoring system of food safety would require good quality control of the enterprises which in turn would require standardized food safety tests from reliable testing laboratories. However, this causes big financial pressure to the small enterprises and overloads the testing industry.

The current technology is able to provide a quick, easy, cheap, effective, rugged, and safe (QuEChERS) fast micro-scale extraction and purification methods for various food samples (Wilkowska and Biziuk 2011). However, these methods still involve the use of sophisticated instruments such as gas chromatography-mass spectrometry (GC-MS), high performance liquid chromatography-mass spectrometry (HPLC-MS) or liquid chromatography-mass spectrometry (LC-MS) for measurement (Choi *et al.* 2015; He *et al.* 2015). The current demand of food contaminant detection requires a faster, on-site and preferentially naked eye detection of food sample analysis. Recent rapid testing of food contaminant is able to shorten the total detection time to 1 d for microorganisms or 30 min for chemicals (Gabaldón *et al.* 2003; Heidenreich *et al.* 2010). Although the accuracy of rapid testing is generally not as good as that

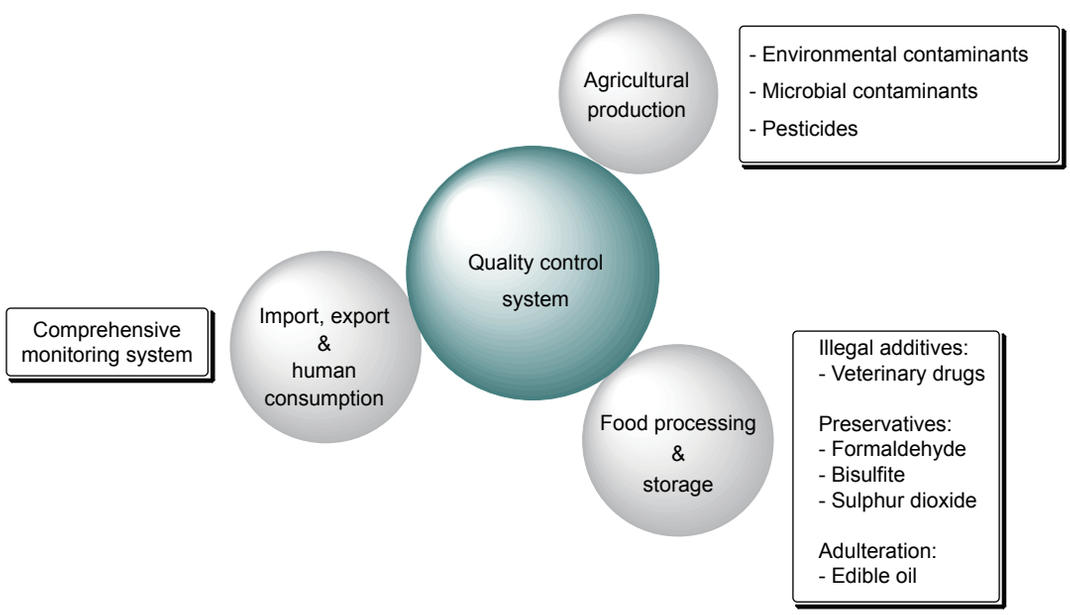

Fig. 1 Different stages of the food supply chain that should be covered by the quality control system and their possible sources of contaminations reviewed in this article.