



Review

Indicators of emerging hazards and risks to food safety

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ABSTRACT

There is a widely felt need to develop methods for the early identification of emerging hazards to food safety with the aim of preventing these hazards from becoming real risks and causing incidents. This paper reviews various activities and previous reports that describe methods to select indicators that can be used for the purpose of early identification of hazards. These indicators have been divided over three different environments, including (i) the environment surrounding food production, (ii) the food production chain from farm to fork, and (iii) consumers. Changes in these indicators are signals that may require follow-up action. Besides indicators that are linked to specific kinds of hazards, the indicators used for vulnerability assessment can help identifying weak spots in the food production system that are sensitive to a broader range of hazards. Based on the various indicators for emerging hazards that have thus been identified in literature, a set of generic indicators is provided that can be useful for the early identification of hazards.

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Abbreviations: BSE, bovine spongiform encephalopathy; CDC, Centers for Disease Control and Prevention; DON, deoxynivalenol; EC, European Community; ECDC, European Center for Disease Control; EEA, European Environmental Agency; EFSA, European Food Safety Authority; EFTA, European Free Trade Association; ERS, Economic Research Service; ESA, EFTA Surveillance Agency; EU, European Union; Eurostat, Statistical Office of the European Communities; FAO, Food and Agricultural Organization; FAOSTAT, Statistical Office of the FAO; FHB, Fusarium Head Blight; FDA, Food and Drug Administration; FIVIMS, Food Insecurity and Vulnerability Information and Mapping Systems; GAP, Good Agricultural Practice; GHP, Good Hygienic Practice; GIEWS, Global Information and Early Warning System; GM, Genetically modified; GMP, Good Manufacturing Practice; GOARN, Global Outbreak Alert and Response Network; GPHIN, Global Public Health Intelligence Network; HACCP, Hazard Analysis Critical Control Points; INFOSAN, International Food Safety Authorities Network; IPCS, International Program on Chemical Substances; ITX, isopropyl-thioxanthone; OIE, World Animal Health Organization (Office International des Epizooties); OTA, ochratoxin A; PFGE, pulsed-field gel electrophoresis; POP, persistent organic pollutant; RASFF, Rapid Alert System for Food and Feed; RFID, radio-frequency identification; SPPA, Strategic Partnership Program Agroterrorism; STEC, Shiga-like-toxin-producing *Escherichia coli* (synonymous to VTEC); UN, United Nations; US, United States; USDA, United States Department of Agriculture; VTEC, verocytotoxin-producing *Escherichia coli* (synonymous to STEC); VWA, Dutch National Food and Consumer Product Safety Authority; WHO, World Health Organization.

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1. Introduction

Food safety has been the topic of some recent policy changes, increased awareness among the public, and various incidents. These developments indicate that there is a need for a system that can identify food safety hazards in an early stage so that these hazards can be tackled in time, before developing into real risks. With regard to food safety hazards that are known as such, measures can be taken towards the prevention and mitigation of these hazards based on their characteristics, behavior and point of entry into the food chain. For example, good practices for agriculture and manufacturing (e.g. good agricultural practice (GAP)), as well as the hazard analysis critical control points (HACCP) approach to assess risks and control them, are now commonplace in many jurisdictions. Yet it can be envisioned that for a number of risks, such measures may not be applicable given that these risks are yet unknown or unanticipated.

The overall aim of the SAFE FOODS project, which is primarily sponsored by the European Commission Directorate for Research's Sixth Framework Program, is to further develop risk analysis of foods based on inputs from advanced research in both the natural and social sciences. Among other things, this is also likely to contribute to the confidence of stakeholders in the European Union's food safety governance. SAFE FOODS is composed of various Work Packages that more or less act as subprojects on different topics, including (i) the use of advanced analytical methodologies to study potential effects of agricultural practices on crop composition; (ii) emerging risks in food safety; (iii) assessment of consumer exposure to food safety hazards by the use of advanced statistical techniques; (iv) confidence of consumers and other stakeholders in risk management in food safety; and (v) institutional arrangements for food safety governance. The findings of all these Work Packages are integrated into a new model on risk analysis, which will be refined with inputs solicited from stakeholders.

The early identification of emerging hazards to food safety is also a major topic of the activities of SAFE FOODS Work Package 2. Previously, Work Package 2 has made a number of accomplishments on this topic, including (i) the establishment of an expert database; (ii) description of a framework for timely identification of emerging hazards; (iii) reports describing systems for timely identification of emerging hazards to food safety or to hazards of another nature that can be exemplary for food safety as well; (iv) an analysis of conspicuous trends in European Union (EU) food safety alerts; and (v) reports reviewing the background and characteristics of a selected range of hazards to food safety caused by microorganisms, mycotoxins, biochemical and chemical agents.

Besides Work Package 2, various parallel projects, such as the EMRISK project funded by the European Food Safety Authority (EFSA), have tackled the issue of early identification of emerging food safety hazards. Against the background of the previous outputs from these projects, the current publication by authors from SAFE FOODS Work Package 2 aims at describing the various types of indicators and, in particular, the methods for their selection that can be used for the early identification of emerging hazards to food safety. This information, together with the working procedures to be reviewed in a follow-up study, can then further provide a basis for the development of a system for emerging hazard identification.

2. Definitions

Various terms with specific meanings are used throughout this report, which therefore would merit from further clarification. Where appropriate, the definitions used are in line with internationally accepted definitions published by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO).

A *hazard* is an agent that has the potential to exert a negative effect on health. An example of a hazard in food is the presence of *Salmonella* bacteria that may cause gastroenteritis. The *risk* is defined as the negative effect of the hazard if it really occurs, which depends on the likelihood of the occurrence- and severity- of the negative effect (FAO, 1995, 1997).

The internationally harmonized model for *scientific risk assessment* is composed of four phases, namely (i) hazard identification; (ii) hazard characterization, that is, the characteristics of specific negative health effects and the dose-response relationships between hazard and effects; (iii) exposure assessment, in which the exposure of consumers ingesting the food containing the hazard is estimated; and (iv) risk characterization, in which the outcomes of the three preceding phases are combined into an assessment and in which also uncertainties are taken into account (FAO, 1995). To illustrate this with an example: the hazard characterization may describe the minimum infectious dose of *Salmonella*, while subsequently the exposure assessment may help estimating the real dose to which consumers are exposed, so that the risk characterization can conclude on the likelihood of gastroenteritis caused by *Salmonella*.

Besides risk assessment, which is the scientific process assessing risks, also two other activities, that is, risk management and risk communication, are considered to be part of the internationally acknowledged risk analysis model for food safety. During *risk management*, policy alternatives are weighed based upon the outcomes of the risk assessment process, and measures to control

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