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Early awareness of emerging risks associated with food and feed production: Synopsis of pertinent work carried out within the SAFE FOODS project

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ABSTRACT

This introduction to the journal's supplement on emerging food and feed safety issues summarizes the objectives and activities of the EU-funded SAFE FOODS project in general and its work package focusing on the early identification of emerging food safety risks, in particular. Within this work package, a number of studies have been carried out on methods enabling the early awareness, identification, and prevention of emerging issues before they can become real risks. The various reviews in this supplement explore the background of the emergence of known food safety risks, both of microbial and chemical/biochemical nature, as well the methods that can be used to identify such risks. Another review identifies a number of chemical and microbiological hazards that are likely to be affected by a changing climate. A major conclusion from these explorative reviews is that monitoring and information exchange systems or procedures are in place to detect, in an early phase, the emergence of potential food safety risks linked to known hazards. Additional systems are needed to predict the development of new potential food safety risks, which are linked to either new hazards or known hazards to which exposure has been altered.

1. Introduction

Recently, the Scientific Committee of the European Food Safety Authority defined an emerging risk as "a risk resulting from a newly identified hazard to which a significant exposure may occur or from an unexpected new or increased significant exposure and/or susceptibility to a known hazard" (EFSA, 2007). The studies on emerging food safety risks that are reported in this supplement to Food and Chemical Toxicology have been performed in the framework of a recently finalized Integrated Project entitled "Promoting Food Safety through a New Integrated Risk Analysis Approach for Foods" (acronym SAFE FOODS), which has been subsidized by the European Commission in the EU 6th Framework Program. Thirty-seven institutions from 21 nations, including EU member states and non-EU nations such as China, South Africa, and Russia, have been involved in this 4-year project. SAFE FOODS, which has been coordinated by Dr. H.A. Kuiper and Dr. H.J.P. Marvin (RIKILT-Institute of Food Safety), has focused on the improvement of risk assessment methods and risk analysis practices for foods produced by different agricultural production practices (high- or low-input systems) and with different crop breeding technologies (traditional, molecular, genetic modification).

2. Context of the research on emerging food safety risks

In more detail, SAFE FOODS has addressed questions regarding: (i) the applicability of new methods for risk assessment, including the use of informative profiling methods to measure the composition of crops grown under different agricultural practices, the use of advanced statistical methods for estimation of consumer exposure to hazardous and beneficial agents in food, and methods for the early identification of emerging risks in food production; (ii) how information about risk assessment should be communicated to the public, and how public concerns can be incorporated into this process; (iii) how effective communication and inclusive public participation in risk management and science and technology policy can be improved; and (iv) the role of institutions involved in risk assessment and management in the light of a broader risk analysis framework, which, besides the results of natural scientific evaluations, also takes social, economical and ethical considerations into account. This has resulted in the design of a new integrated risk analysis framework for foods and feed and their methods of production. More information on the SAFE FOODS project can be found on the project website (www.safefoods.nl)

One of the objectives of SAFE FOODS has been to design a European working procedure for early identification of emerging chemical or microbial risks in food production chains in an expanding European market. This task has been conducted in Work Package 2 of the SAFE FOODS project. As part of this task, the various

Abbreviations: DON, deoxynivalenol; EU, European Union; FHB, fusarium head blight; RASFF, rapid alert system for food and feed.

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reviews that are featured in this supplement have been authored by scientists of the participating institutions.

3. Review of emerging food safety risks and possible methods for their early identification

To be able to propose a system for the early identification of a food-borne hazard which may constitute a risk, it is important to make an inventory of – and critically evaluate – early warning systems that are already in place, and to understand the shortcomings/limitations of these systems. Various early warning systems that are considered to be relevant for this purpose have been reviewed from a global perspective. It has thus become apparent that, besides the challenges of timely detection of a hazard, also rapid information exchange to relevant parties is crucial in such systems for the successful prevention of a hazard to develop into a risk. The warnings issued by the systems reviewed are either directly or indirectly linked to food-borne hazards. An example of the last category is systems dedicated to the prediction of the presence of mycotoxins in cereals such as maize based on meteorological data.

Furthermore, the literature has been screened for information on emerging chemical and microbial risks. Based on the information thus found, several specific topics have been selected for further analysis as case studies with the aim of promoting insight into the development of specific food safety problems. This also enables the formulation of recommendations that would improve the identification of the same or similar hazards in an earlier stage and thereby avoiding a food safety incident as observed in some of the cases investigated.

This special issue of Food and Chemical Toxicology presents the following reviews featuring the results of the above mentioned studies carried out by Work Package 2. The papers are grouped under four main headings: (i) early awareness, identification, and assessment of emerging food safety risks; (ii) emerging microbial risks; (iii) emerging chemical and biochemical risks, and (iv) emerging risks linked to global climate change.

3.1. Early awareness, identification, and assessment of emerging food safety risks

Early identification systems for emerging food-borne hazards, i.e. substances or other agents in food that could cause adverse health effects, are the topic of the review by Marvin et al. (2009b). This review distinguishes three main categories of systems for early identification, including reactive systems, predictive early warning systems, and systems based on a holistic approach. The last category of systems uses information from outside and inside the food production chain to predict the emergence of a food safety risk. In their conclusions, the authors note that besides rapid identification, also communication of potential risks to the relevant authorities is crucial to effective risk management. Moreover, there is a need for the establishment of performance criteria for these systems.

One of the predictive early identification systems highlighted by Marvin et al. (2009b) is further elaborated by Prandini et al. (2009a), namely the system for the prediction of mould infestation of cereal crops and the formation of mycotoxins by these moulds leading to crop contamination. More specifically, Prandini et al. (2009a) consider the infection of wheat with *Fusarium* moulds during crop growth in the field, also known as the Fusarium head-blight disease (FHB). FHB, in turn, can give rise to formation of deoxynivalenol (DON) and other mycotoxins. Whilst the various systems considered are used in specific global areas, they share the common feature of using meteorological data as inputs for the prediction of FHB and DON. A distinction is made between descriptive and explanatory models, each having its own limits.

The potential utility of trend analysis of incidences of hazards in food as reported through the EU Rapid Alert System for Food and Feed (RASFF) has been explored by Kleter et al. (2009b). RASFF members, such as national food control authorities of EU member states, are required by EU regulations to report any measures they take against food safety risks (e.g. recalls, rejections, specific marketing conditions) as "alert" – and "information" – notifications, which can be also relevant to other members. RASFF may be considered a reactive system according to the categorization by Marvin et al. (2009b), generally focusing on known hazards in food being monitored in national programs, whilst also other unexpected hazards posing a food safety risk may be reported. RASFF data covering four years of reporting have been scrutinized for emerging trends in the numbers of reports. The authors have thus found a number of emerging trends, for which they conclude that for most of them, the national and EU authorities have already taken measures, and RASFF has paid attention to them in its annual reports. These authors also note that it could be useful to combine RASFF data with other data, such as risk management measures, trade flows, and public health reports, which is currently pursued by the statistical office of the European Communities (Eurostat).

3.2. Emerging microbial risks

In a series of three installments, Kelly and co-workers highlight the various factors that influence the acquisition of pathogenic traits through horizontal gene transfer, i.e. the exchange of genetic information between different microbial species, by microorganisms that can occur in food. Such an exchange of genetic material may result in non-virulent strains of a potentially pathogenic bacteria becoming virulent. Kelly and co-workers consider this potential risk against the background of the emergence of new pathogenic strains of food micro-organisms over the last few decades, as well as the knowledge on pathogens that has amassed, including the elucidation of the genetic information in these micro-organisms as well as their mechanisms for horizontal transfer of genetic information.

Kelly et al. (2009a) consider the various mechanisms by which bacteria species can interchange genetic information, and, more specifically, which mechanisms are operational in major food pathogens and how they have contributed to the virulence of these pathogens. It is considered, for example, that the transfer of "genomic islands" containing one or multiple virulence-associated genes may cause "quantum leaps" in the evolution of pathogens. Also bacteriophages have played a major role in this. Also other mechanisms, including DNA plasmid transfer, can have significant effects.

The various virulence factors that occur within a number of selected food pathogens, as well as known occurrences of horizontal transfer of these factors, are described by Kelly et al. (2009b). These virulence factors include, among others, antibiotic resistance genes, toxins, and pathogenicity islands. It is concluded that there are many accounts of horizontal transfer of these factors between pathogens through various mechanisms. Moreover, it is stated that more research is needed into the potential transfer from pathogens to commensal recipient bacteria in the same environment, such as the host's gastrointestinal tract.

Kelly et al. (2009c) explore the knowledge on the occurrence of gene transfer within selected environments that are relevant to food production and consumption. Whilst these authors conclude that there has been no evidence for the horizontal transfer of genes from genetically modified crops to micro-organisms, evidence suggests that gene transfer is likely to occur between micro-organisms in the oral cavity, gastrointestinal tract, and ruminants' rumen. Furthermore, dissemination of toxin-expressing strains of the pathogen *Escherichia coli* and the transfer of the genes encoding