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Towards biotracing in food chains

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ABSTRACT

Biotracing is tracing (backward)/tracking (forward) biological contamination in the food/feed chain. Advances in detection technologies, improvements in molecular marker identification, clearer understanding of pathogenicity markers, improved modelling methodologies and, more importantly, the integration of these disciplines will lead to better capability in full-chain tracing and tracking biological contaminations (biotracing). The advantages of improved biotraceability are faster intervention, limited recalls and more targeted remedial action. The project is not dealing with risk assessments but developing tools that can be used in "second-generation" risk assessments involving quantitative microbiology. This concept is the core activity of BIOTRACER, which is an Integrated Project (2007–2011) funded by the EU 6th Framework Programme. The research in biotracing is organised into five Research Areas, and 21 cross-disciplinary work packages that cover tracing and tracking of contamination in feed, meat and dairy chains, in addition to accidental and deliberate contamination of bottled water. The BIOTRACER Consortium consists of 46 partners, including Europe's largest food/feed industries, several SMEs, and relevant International Cooperation (INCO) countries. The Consortium includes experts in predictive microbiology, database developers, software companies, risk assessors, risk managers, system biologists, food and molecular microbiologists, legislative officers, standardization and validation members and food retailers. The outcomes will ensure a more reliable and rapid response to a microbial contamination event.

1. Introduction

Traceability systems allow a product to be traced to its source of origin (Barker et al., 2009). This is facilitated by labelling information on the product, often in the form of a barcode. Biotracing has a similar approach, except that biological agents, such as microorganisms or their toxins, are traced (backward)/tracked (forward) (Fig. 1). In this case, however, the biological agent cannot be labelled with a unique marker, although this is the ultimate aim, making biotracing more challenging to implement. Advances in detection technologies, improvements in molecular marker identification, clearer understanding of pathogenicity markers, improved modelling methodologies and more importantly the integration of these disciplines will lead to better capability in biotracing.

Biotracing involves a multidisciplinary approach from statistically based sampling methodologies (Andersson and Haggblom, 2009), to accurate detection methods (Josefsen et al., 2007), to understanding microbial physiology (Belessi et al., 2008), to formulating mathematical models, to software development to make such models user friendly and useful decision support tools (Pouliot and Sumner, 2008) (Fig. 2). It is a whole-chain approach — information relating to the entire food chain is important. In addition, this has a potential impact on early tracing actions (Fig. 3).

Biotracing is not the same as risk assessment or hazard analysis critical control points (HACCP) system, but incorporates the benefits from those systems. Biotracing is based on a novel concept integrating traceability hardware and software with biological safety in a full-chain driven approach (such as dairy or feed).

2. Advantages of biotracing

The main advantage of biotracing is the high degree of integration of laboratory data into different steps of the production chain. While HACCP focuses on the critical production points, biotracing deals with the entire chain, from the primary production at farms (Olsen et al., 2009), through transportation, storage, distribution, shelf-life issues and consumption by consumers. An example here is the biological information on the significance of strains that are isolated during routine quality control checks: does the strain have virulence traits, can it confer pathogenicity, is it recurrent, can it survive the environment of the food production in question? (Champion et al., 2005).

As compared to risk assessment, biotracing provides tools for improved risk assessment, but does not stop there. Biotracing extends

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Fig. 1. Any process or production chain has access points where contamination or unexpected influences can enter the process.

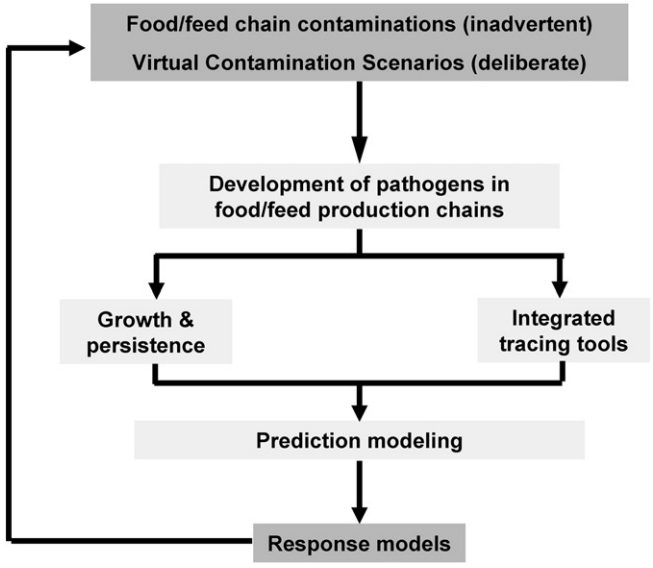

Fig. 2. Illustration of biotracing concept: food chain contaminations are either inadvertent or deliberate events that need to be carefully modelled. The models must take into account development of pathogens in relevant matrices along the production chains. The information on growth and persistence of hazardous pathogens, linked with laboratory information systems and tracing tools will result into accurate models that can predict the level and impact of contamination on food safety. The outcome will support response models that support risk-based decision-making for industry and regulators.

into risk management by providing risk managers with decision-making tools necessary for a science-based approach to regulation of food safety, product recall and design of traceability systems (Wein and Liu, 2005).

Having an established biotracing system can contribute to:

- Immediate intervention
- Pre-emptive knowledge
- Targeted recalls as a result
- Limit downtime
- More specific remedial action.

3. Improvements necessary for better biotracing

In order for biotracing to become an established feature of food safety programmes, certain advances beyond the current state-of-the-art are necessary. These include:

- Development and application of more scientific and statistically based sampling plans
- Improved detection methods that can incorporate typing information
- Improved understanding of microbial physiology in food and its relationship to pathogenesis in humans
- Alternative modelling techniques that could include infectivity data from microbial physiology in food.

4. BIOTRACER project

BIOTRACER is a one of the world's largest food microbiology projects that is funded (2007–2011) by the European Union to support research in improved food safety (www.biotracer.org). It has an external funding of 11 million Euros, 46 project partners from 24 countries, including countries that supply feed to Europe such as Brazil, Indonesia, Russia and South Africa. The main objective of BIOTRACER is to create tools and models that improve tracing, risk assessments and support decision-making in cases of both accidental

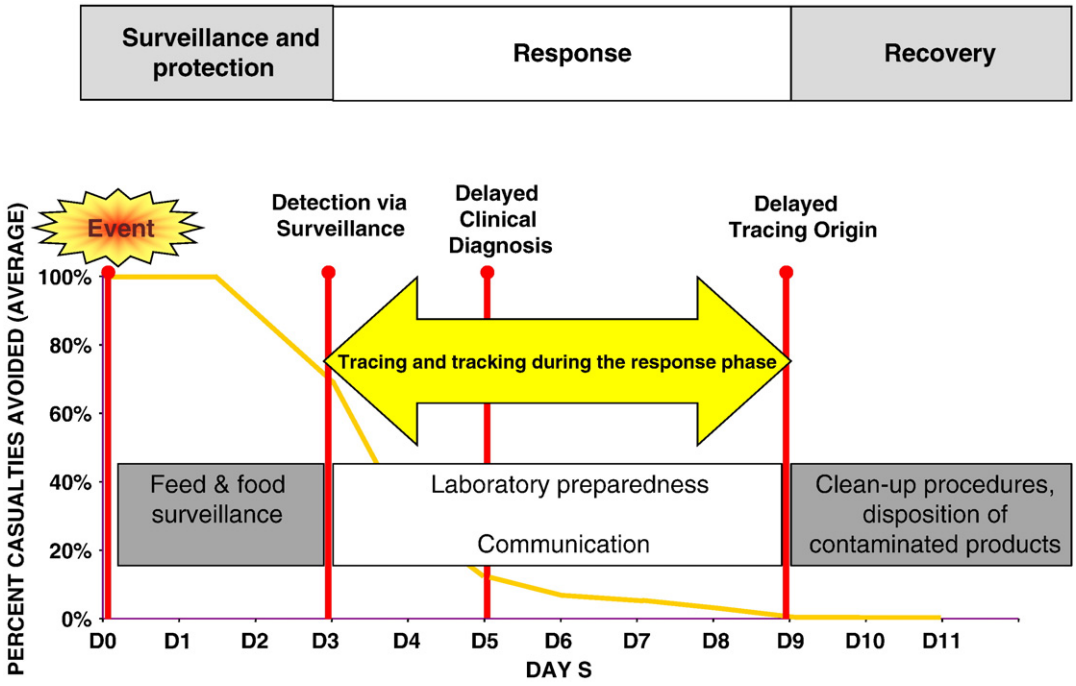

Fig. 3. The potential impact of biotracing on early tracing actions and rapid responses. The aim of biotracing is to shift the response time to the left by improving detection, increasing preparedness and communication, improving tracking and tracing and therefore avoiding casualties.