Future Challenges in Food Analysis from a food safety perspective

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Access to safe and nutritious food is basic requirement for human health

Food analysis is a key element in ensuring

- Safe food
- Nutritious food
- Quality of food
Setting

- **Globalisation of food trade**
  - Food and food safety problems travel over long distances

- **Industrialised food production**
  - Use of chemicals
  - Gene modified organisms (GMO)

- **Extensive development in techniques for microbiological and chemical analysis**
  - Genetic techniques
  - Instrumental techniques in separation, spectroscopy and hyphenated approaches
The risk of unsafe food is substantial

• Harmful agents
  – Parasites, bacteria, virus and prions
  – Allergens
  – Chemical compounds
  – Radioactive substances

• Health problems
  – Infectious diseases
    • Enteric diseases, hepatitis and sequelae
  – Non-communicable diseases
    • Impaired development (e.g. lead)
    • Cancer (e.g. aflatoxin)
    • Allergy
Linking unsafe food to health

• WHO initiative
  – Estimate the Global Burden of Foodborne Diseases
  – Start 2006 - final report expected in 2015

World Health Day 7 April 2015:
  – Food Safety
Avian Influenza

The Mad Cow Chaos
Foodborne infections and food analysis

Challenge: link source with disease in human outbreaks

Genetic based technology

- Moving from culture based to culture independent techniques (based on DNA/RNA profiles or sequences)
  - Sensitive, detection of pathogens with low infective dose
  - Specific and rapid

- Verification by culturing is not always possible
  - DNA method might have a higher sensitivity
  - False positive
  - Method does not distinguish between dead or living organisms
  - Presence of virulence genes in non-pathogens/ bacteriophages
Emerging importance of food associated viruses

- Noroviruses, rotaviruses, hepatitis A and other relevant viruses

- Determination of viruses in food matrixes is feasible, but variable efficiency

- Methods need to be improved.
Food allergens

• Prevalence for any food:
  – self-reported 3-35% (Rona et al. 2007), 3-6% (Sicherer 2011). Dependent on diagnostic tool
• Nature of reaction: Mild – severe – anaphylaxis
• Minute amounts are needed to cause a reaction
• Natural constituents of foods
• Cross-contamination of foods
Food allergens

Incidents of food allergy

- Identification and quantification of allergens in the food samples

- Linking intake of allergens to allergic reactions
Chemicals in food and food analysis

• Chemicals used in food production and distribution and chemicals deliberately added to food:
  – Plant protection products, veterinary medicines, food additives, food packaging materials etc.

• Environmental contaminants
  – Persistant pollutants, industrial chemical, chemical products

• Toxins of natural origin
  – Mycotoxins, marine biotoxins, inherent plant toxins
Chemical Contamination and Food Crises

- Dioxins – several incidents
  - eggs (Germany), pork meat (Ireland), chocolate (Belgium)

- Melamine in milk powder (China)

- Mineral oil in vegetable (sunflower) oil (Ukraine)
Maximum levels

• Chemicals used in food production
  – Use and/or maximum levels

• Environmental contaminants
  – Maximum levels for several substances established for food and feed

• Natural toxins
  – Maximum levels for some substances established for food and some for feed
Environmental Chemical Contaminants

• A large number of persistent organic pollutants (POPs) have been phased out and banned
  – Still residues in the environment

Hexachlorobenzene in Breast milk
New emerging POPs

Brominated compounds in Breast milk

Perfluorinated chemicals (PFC)
Environmental contaminants and natural compounds

What is the hazard and occurrence in food?

Who owns the problem?
Aflatoxin – disease burden

- Mycotoxin: Aspergillus flavus
- Potent liver carcinogen (with chron. hepatitis B)
- May play a causative role in 25 200 - 155 000 cases of liver cancer each year, worldwide (4.6 – 28 %)

(Liu and Wu 2010)
Recycling of products and waste

• May eventually end up in the food chain

• These aspects should be considered as a part of the evaluation of new products
Migration of mineral oil from printing ink in recirculated paper board to rice

New paperboard

8 month storage

Rice

EFSA / Grob. K
Mineral hydrocarbons (MOH)

Complex mixtures

Food standards: physical chemical parameters not chemical composition
Complexity of food grade MOH – 2D GC

K Grob, personal com
Natural toxins

• Complex structures
• Lack of standards
• Several analogues
Moving from animal bioassays to chemical analysis

**Algal toxin analogues**

- **Algae species**
- **Secondary metabolites**
- **Shellfish**
  - **Algal toxin analogues**
  - **Algal parent compounds**
  - **Biotransformation products**
  - **Variable biological activity**
Complexity of chemical structures of marine biotoxins

Okadaic acid group

Domoic acid

Saxitoxin group

Azaspiracid group

Yessotoxin group

Pectenotoxin group
Metal speciation - arsenic

• Health risk assessed in relation to inorganic arsenic
  – Global disease burden new cancer cases per year:
  – Skin, lung and bladder for each about $10-120 \times 10^3$

• What about organic arsenic?
  – Major part of arsenic in seafood organic
Organic arsenic in seafood
Linking exposure to health

Presence of chemical substances in food

– What is the risk to the consumer?

– What do we know about hazard (ability to cause harm)?

– What do we know about the exposure?

– Are susceptible groups (e.g. pregnant women, children)?
Risk Assessment

Hazard identification

Concentration in food

Consumption of food

Hazard characterisation

Exposure via food

Exposure biomarker

Risk characterisation
Linking exposure to health

Toxicological studies
- Traditional animal studies resource demanding

New development
- High throughput screening in in vitro systems

Epidemiological studies
- Observational studies
- Exposure assessment
- Long time from exposure chemicals to health outcome
Meeting future challenges in food safety and analysis

A multidisciplinary approach is needed:

Analysts
Microbiologists
Epidemiologists
Toxicologists
Nutritionists
Food consumption specialists
Statisticians
Thank you for listening!