Chemical Hazards in Food and Feed
Towards an integrated risk assessment

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European Food Safety Objectives
General Food Law: EC 178/2002

From the Farm to the Fork
• Integrated Quality Control
• Integrated Risk Assessment

In the period 2003-2012, the CONTAM Panel published 107 scientific outputs
(55 on food, 43 on feed, 9 on food and feed).
The CONTAM Mandates: Risk Assessment of Contaminants in Food and Feed

✓ Persistant organic pollutants
✓ Metals, metaloids and other chemical elements
✓ Mycotoxins
✓ Marine biotoxins
✓ Plant toxicants (alkaloids) in food and feed
✓ Food process contaminants
✓ Feed process contaminants (coccidiostats)

EFSA Journal 2012; 10 (10); s1004
Risk Assessment of Contaminants in Food

✓ Data sources & data mining
  ✓ Scientific literature, official national reports (EU & MS, Codex) AND DCM (EFSA Data Collection and Monitoring)
  ✓ Human exposure (Comprehensive Food Consumption Database (> 20 MS)

EFSA Journal 2012; 10 (10); s1004
Risk Assessment Principles

Dealing with “unavoidable” substances
Identified by Mode of Action (Hazard Identification)

Health-based guidance value (HBGV)

Reference points:
BMDL (dose response assessment)
(benchmark dose lower confidence limit (95 perc. confidence interval))
NOAEL (LOAEL) & uncertainty factors
ARD acute reference dose (short term - incidental – exposure)
MOE – Margin of exposure (genotoxic and carcinogenic substances)

EFSA Journal 2012; 10 (10); s1004
The CONTAM mandate

Risk assessment on contaminants in the food chain

Objectives:
To perform risk assessment and to identify where appropriate health-base guidance values for food and feed
Feed Safety in Europe: Key issues

- FMD
- Swine fever
- Avian influenza
- BSE/TSE
- Listeria in cheese
- Salmonella/Campylobacter in poultry
- Heavy metals (fish)
- Dioxins in poultry meat
- Hormones in veal and beef
- NDL PCBs
- PBDE’s
- Melamine 2010/2011
- Antimicrobial Resistance (MRSA, ESBL)
- STEC, 2011

RISK MANAGEMENT at the community level
Directive EC 32/2002
Undesirable substances
(including pesticides, organic pollutants)
in animal feeds

• Establishment of safe exposure levels for the individual animal, sensitive species, or categories (age/production groups)

• Evaluation of the carry-over from feed to foods of animal origin per animal species – per animal product (milk, meat, eggs, honey)

• Contribution of residues in animal tissues to total human exposure

Addressing all animal species, including companion animals (animal health aspects), minor species and farmed fish
Hazard Identification: Feed materials

Formulated feeds (controlled by EC 32/2002)
  - Pasture/roughages
  - On-farm preserves
  - By-products: milling, oilseeds
  - Biofuel/biodiesel DDG(S)
  - Vegetables & new plant varieties
  - New technologies

Emerging (natural) toxins
Global trade / contaminants
Estimates of undesirable contaminants
Accumulation/degradation during processing
New contaminants/products (glycine, antibiotics)
PSM, fungal & bacterial toxins (spoilage)
Nanoparticles
Hazard Identification: Feed materials

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Exposure assessment

Considerations

*Within Europe:*
Animal diets are highly variable
- per species / breed
- per age group
- per (production) category

**Consensus**
Average animal feed composition based on nutritional needs
(CONTAM 2011/2012) →
Quantitative exposure assessment

**Remaining challenges:** current trends in animal nutrition

- Replacement of animal proteins in petfood
- Dietary requirements of farmed fish
- Feed additives
- Global trade in feed materials (new feed materials)
Dose-response assessment: Oral bioavailability

Pre-systemic elimination in the rumen

Genetic polymorphisms

Systemic circulation

De-conjugation Excretion

Effect

Pre-systemic Elimination (biotransformation)

Species differences!
Risk characterization

Dose-response assessment

Anecdotal evidence of toxicity misses dose accuracy

Physiological differences (multi-species assessments)

Limited availability of professional dose-response data

Identification of threshold of toxicological concern (TTC equivalent)
Risk characterization

Dose-response assessment: toxicological endpoints of concern

Health and productivity
- Weight gain & feed utilization
- Milk-meat-egg production
- Reproductive capacity
- Immune-competence
- Organ-specific lesions

Long-term effects (cancer)
Developmental toxicity
Endocrine effects

Identification of a threshold of toxicological concern (TTC equivalent)
Risk characterization

Dose-response assessment: supportive parameters (TK)

ADME(T)
Allometric scaling

- Absorption
  - Rumen barrier function
  - Intestinal barrier
  - Efflux transporters
  - Pre-systemic elimination

- Distribution
  - physico-chemical data
  - biological barriers

- Metabolism / Biotransformation
  - Inter- / intra-species variability
  - Genetic polymorphisms

- Excretion
  - renal capacity
  - urinary pH

Integration of information from other sources
Example: R & D veterinary medicinal products
Additional Risk Assessment Tools

Mode of Action (MoA) based approach

- Facilitates cross-species risk characterization
- Uses mechanistic information from *in vitro* studies
- Uses recent progress in molecular and systems biology
- Identifies biomarkers of exposure and effect
- Supports comparison of experimental data with epidemiological observations

Meeting forthcoming challenges:
Assessment of multiple exposure and long-term health outcomes
Major achievements

• Identification of risks associated with foods from animal origin and their contribution of overall human exposure

• Stratified and transparent approach in RA for all major animal species

• Establishing prerequisites for a quantitative risk assessment (i.e. exposure assessment)

• Identification of uncertainties and research needs

Meeting the objectives of General Food Law: EC 178/2002
Integration of Food and Feed Risk Assessment

Mode of Action (MoA) based approaches:

*In vitro* data:
- Qualitative analysis of a toxicological effect
- ADME(T) information
- Species differences

- Toxicogenomics / metabolomics / -omics
- Characterization of effects
- Biomarkers of effect – monitoring tools (population analyses)

Assessing the **overall risk probability (ORP)** under real life conditions of multi-source exposure to multiple chemical substances
Conclusions

The risk assessment of contaminants in the food chain
- is a non-static process
- is a multi-disciplinary task
- needs to be flexible (see emerging risks) without losing consistency

Recent toxicological paradigms make use of
- physiological data (TD/TK)
- integrated approaches using new technologies and models

Forthcoming analyses will include
• the assessment of multiple substance-exposure scenarios
• the integration of health indicators (pre-existing disease that may influence the long-term health outcomes)
Food Safety & Food Security
By 2050 an expanded world population will be consuming two thirds more animal protein than it does today, bringing new strains to bear on the planet's natural resources. Populations and income growth are fueling an ongoing trend towards greater per capita consumption of animal protein in developing countries.

Meat consumption is projected to rise nearly 73 percent by 2050; dairy consumption will grow 58 percent over current levels.

Increases in production will need to come from improvements in the efficiency of livestock systems in converting natural resources into food and reducing waste. This will require capital investment and a supporting policy and regulatory environment.
Food Safety & Food Security

Thank you for your attention!