Overview of Significance of Residues and Chemical Contaminants in Milk

Michael Hickey
Dairy & Food Consultancy
Types of Residues and Contaminants found in Foods

Biological

Chemical

Physical
For the purposes of this presentation

**Contaminants:**
Substances that are found in food, as a result of entering at any stage of the food chain. Usually they may enter food unintentionally – but occasionally due to being intentionally added with fraudulent intent.

**Residues:**
Substances that are found (or remain) in food as an unintended consequence of using phytosanitary products (pesticides) or veterinary drugs.
Simple Dairy Farm to Fork Chain

1. Dairy Farm
2. Milking Process
3. Transport to Dairy Plant
4. Dairy Plant
5. Retail Store
6. Consumer
Potential Contamination Sources - the Raw Material Source

Direct

Indirect

1. Release of radioactive isotopes
2. Radioactive dust carried long distances by the wind
3. Radioactive dust falls to earth or is washed out by rain
4. Grass eaten by cattle
5. Grass eaten by livestock
6. Irradiated meat and milk eaten by people

- Irradiated grains absorbed from soil and water by grass
- Irradiated feed pellets
- Irradiated mineral blocks
- Irradiated water
Morinaga Incident – recombined milk contaminated with sodium arsenate which had inadvertently contaminated a permitted food additive disodium phosphate

PBB - polybrominated biphenyl (a flame retardant)
Some examples of contamination (2008 – 2013)

- **2008**
  - Melamine contaminated milk and infant formula (China)

- **2009**
  - Soy beverage with high iodine levels (Australia)

- **2008**
  - Dioxin & PBCs in Pork products (Ireland)

- **2009**
  - Pork products containing clenbuterol (China)

- **2011**
  - Dioxin contaminated animal feed used by poultry and pork producers (Germany, Netherlands & UK)

- **2010**
  - Fukushima nuclear plant disaster (Japan)

- **2012**
  - DCD in Milk Powder (New Zealand)

- **2012**
  - Various foods contaminated with DDAC (Belgium, Denmark, Germany & Netherlands)

- **2013**
  - Aflatoxin in Milk (Romania, Serbia & Croatia)

DCD – Dicyandiamide – a nitrification inhibitor that may be added to fertilizer

DDAC – Didecyldimethylammonium chloride – a Quaternary Ammonium Compound [QAC] – was authorized in EU as an active substance in plant protection products (exclusively for indoor uses for ornamental plants) – approval now withdrawn (by Implementing Reg. No 175/2013)
The EU Dioxin Case 2010

How the International Food Scare Spread

Dec 12: Fourteen tons of liquid egg sold to Kenney Foods of Cornwall and Memory Lane Cakes of Cardiff

Dec 140,000 contaminated eggs sent from German farms to Netherlands to be liquefied, and pasteurised

From March 2010: Halle and Jentisch factory in Schleswig-Holstein mistakenly sends oil intended for biofuels and containing dioxins to 23 animal feed manufacturers across Germany

Nov-Dec: 3,000 tons of contaminated animal feed reaches 1,000 poultry and pig farms across Germany

Jan 7: Tesco, Sainsbury's and Morrisons withdraw products which may be affected

Kenney Foods of Launceton, Cornwall, uses liquid egg to make supermarket own brand quiches.

Memory Lane Cakes of Cardiff use eggs to make cakes for supermarkets - including Sainsbury's Chocolate Caterpillar Cake
**POPs**

**The Original “Dirty Dozen” (2001)**

<table>
<thead>
<tr>
<th>Pesticides</th>
<th>Unintended by-products</th>
<th>Industrial chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aldrin</td>
<td>Dioxins</td>
<td>Polychlorinated biphenyls (PCBs)</td>
</tr>
<tr>
<td>Chlordane</td>
<td>Furans</td>
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<tr>
<td>Dichloro-diphenyl-trichloroethane (DDT)</td>
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<tr>
<td>Dieldrin</td>
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<tr>
<td>Endrin</td>
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<tr>
<td>Heptachlor</td>
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<tr>
<td>Hexachlorobenzene (HCB)</td>
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<tr>
<td>Mirex</td>
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<tr>
<td>Toxaphene</td>
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</tbody>
</table>

POPs = Persistent Organic Pollutants – all are polyhalogenated hydrocarbons

1 Under the Stockholm Convention on Persistent Organic Pollutants - 22 May 2001
## The 10 new POPS

<table>
<thead>
<tr>
<th>Pesticide by-products</th>
<th>Industrial Chemicals (e.g. Flame Retardants)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlordecone</td>
<td>Hexabromobiphenyl (HBB)</td>
</tr>
<tr>
<td>beta-Hexachlorocyclohexane (alpha-HCH)</td>
<td>Hexabromodiphenyl ether and heptabromodiphenyl ether</td>
</tr>
<tr>
<td>beta-Hexachlorocyclohexane (beta-HCH)</td>
<td>Pentachlorobenzene (PeCB) (also a Pesticide)</td>
</tr>
<tr>
<td>Lindane (gamma-HCH)</td>
<td>Perfluorooctane sulfonates and perfluorooctane sulfonate fluoride (PFOS)</td>
</tr>
<tr>
<td>Endosulfan and related isomers</td>
<td>Tetrabromodiphenyl ether and pentabromodiphenyl ether</td>
</tr>
</tbody>
</table>
Elements of Risk Analysis

RISK ASSESSMENT

RISK MANAGEMENT

RISK COMMUNICATION
Chemical Contaminants in Food - EU

- **Nitrates**
  - as NO$_3$

- **Mycotoxins**
  - Aflatoxins – B1, M1, and mixed B1/B2/G1/G2
  - Ochratoxin A
  - Patulin
  - Deoxynivalenol
  - Zearalenone
  - Fumonisins
  - T2 and H2 toxin

- **Metals**
  - Lead
  - Cadmium
  - Mercury
  - Tin (inorganic)
  - [Arsenic]

- **Dioxins and PCBs**

- **PAHs**

- **3-MCPD**

- **Melamine and its analogues**

From Regulation (EC) No 1881/2006
Pesticide Residue Risk Analysis

Risk Assessment
- Dose-Response Assessment
- Hazard Identification
- Exposure Assessment

Risk Characterization

Risk Management
- Legal Considerations
- Public Health Considerations
- Social Factors
- Economic Factors
- Public Consideration
- Risk Management Options

Risk Management Decision

EFSA PPR Panel

EU Commission Member States

Scientists

Regulators

JMPR

CCPR Codex Commission
Pesticide Functional Classes (CODEX)

www.codexalimentarius.net/pestres/data/pesticides/index.html

179 Pesticides Scientifically evaluated by JMPR and MRLs set for Foods

Agaricide 12 (8)
Aphicide 1 (1)
Fumigant 3 (0)
Fungicide 57 (32)
Herbicide 15 (13)
Insect Growth Regulator 2 (1)
Insecticide 79 (59)
Nematicide 1 (1)
Plant Growth Regulator 5 (4)
Scald Control Agent 1 (0)
Storage Scald Preventer 1 (1)
Synergist 1 (1)

www.codexalimentarius.net/pestres/data/pesticides/index.html
Fumigant
3

Nematocide
1

Plant Growth Regulator
5

Herbicide
15

Insect Growth Regulator
2

Insecticide
79

Agaricide
12

Aphicide
1

Fumigant
3

Storage Scald Preventer
1

Generic
1

Synergist
1

Scald Control Agent
1

Nematocide
1

MRLs set for
121
of these Pesticides in Milk/Milk Fat

www.codexalimentarius.net/pestres/data/pesticides/index.html
Functional Categories of Veterinary Drugs (CODEX)

59 MRLs in Total set for Foods

- Adrenoceptor Agonist 1 (1)
- Trypanocide 2 (2)
- Glucocorticosteroid 1 (1)
- Antiprotozoal 3 (1)
- Antimicrobial 22 (15)
- Anthelmintic 11 (6)
- β-Adrenoceptor blocker 1 (0)
- Tranquilizer 1 (0)
- Insecticide 8 (5)
- Growth promoter 2 (0)
- Production aid 7 (0)
- Tranquilizer 1 (0)

31 MRLs for set for Milk

www.codexalimentarius.net/vetdrugs/data/vetdrugs/classes.html?lang=en
### CodeX Alimentarius Commission

Maximum Residue Limits for Veterinary Drugs in Foods

Updated as at the 35th Session of the Codex Alimentarius Commission (July 2012)

<table>
<thead>
<tr>
<th>Veterinary Drug</th>
<th>Page</th>
</tr>
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<tbody>
<tr>
<td>Albuterol</td>
<td>2</td>
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<td>Almac 120</td>
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<td>Almac 20</td>
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<td>Aspirin</td>
<td>4</td>
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<td>Avain</td>
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<td>Azithromycin</td>
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<tr>
<td>Bepentene/Porcine benzylpenicillin</td>
<td>5</td>
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<tr>
<td>Carbamazepine</td>
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<tr>
<td>Carboxal</td>
<td>6</td>
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<tr>
<td>Chloramphenicol /Chloramphenicol/Thiamphenicol</td>
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<tr>
<td>Clofibrate</td>
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<td>Clofibrate</td>
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<td>Clofibrate</td>
<td>10</td>
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<tr>
<td>Cyamantan</td>
<td>11</td>
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<tr>
<td>Cydolactone</td>
<td>12</td>
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<tr>
<td>Dextromethorphan</td>
<td>12</td>
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<td>Dextrose</td>
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</tbody>
</table>

### Notes

- Residues of ~90 Veterinary Drugs evaluated by JECFA
- 59 MRLs in Total set for Foods
- 31 MRLs for set for Milk
- rBST not included (yet!)
The EU Pesticides Database includes Approved, Non-approved, Pending, and substances that are not plant protection products. It lists a total of 1297 substances.

The database allows filtering by various criteria such as Category, Status, Class (Dir. 67/548/EEC), Class (Reg. 1272/2008), Authorisations, Legislation, ADI, ARRD, AOEL, Approval date, and Expiration date.

A search results page shows 1297 entries found with a list of active substances, including:

- (4Z,Z)-7,9-Dodecadien-1-ol
- (E)-10-Dodec-1-en-1-yl acetate
- (E)-11-Tetradecen-1-yl acetate
- (E)-1-Methyl-6-methylene-2,7-octadien-1-ol (myrcenol)
- (E)-2-Methyl-6-methylene-3,7-octadien-2-ol (isomyrcenol)
- (E)-5-Decen-1-ol
- (E)-5-Decen-1-yl acetate
- (E)-8-Dodec-1-en-1-yl acetate
- (E)-4,7-Tetradecadien-1-yl acetate
- (E)-7,9-Dodecadien-1-yl acetate
- (E)-6,10-Dodecadien-1-0l
- (E)-8,10-Dodecadien-1-yl acetate
- (E)-2,13-Octadecadien-1-yl acetate
- (E)-1,3,5-Tridecantriyl(3,3,6,9,12,15-hexasilacyclo-octadeca-3,6,9,12-tetraene) (linesil)
- (Z)-11-Hexadecen-1-0l
- (Z)-11-Hexadecen-1-yl acetate
- (Z)-11-Tetradecen-1-yl acetate
- (Z)-15-Hexadecen-1-yl acetate
- (Z)-13-Octadecen-1-yl acetate
- (Z)-3-Methyl-5-isopropenyl-3,4-decadien-1-yl acetate
- (Z)-3-Methyl-5-isopropenyl-5-decen-1-yl acetate

The database is accessible at: [http://ec.europa.eu/sanco_pesticides/public/?event=activesubstance.selection](http://ec.europa.eu/sanco_pesticides/public/?event=activesubstance.selection)
Total of just 440 APPROVED Substances
### EU Pesticides Database

#### Active substances

**Category**: Herbicide

**Status**: Approved

<table>
<thead>
<tr>
<th>Class. (Dir. 67/548/EEC)</th>
<th>-</th>
</tr>
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<tbody>
<tr>
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<td>-</td>
</tr>
<tr>
<td>Legislation</td>
<td>-</td>
</tr>
</tbody>
</table>

**Find substance**

- 2,4-D
- 2,4-DB
- Acriflavine
- Actinonin
- Amidonitril
- Amidosulfuron
- Aminoaizol (amino-triazol)
- Amineetron
- Atrazin
- Benthalid
- Benturanil
- Benthalanil
- Benturanil
- Bentazon
- Bifetox
- Bipyridazin
- Bromoxynil
- Capric acid (CAS 334-48-5)
- Caprylic acid (CAS 124-07-2)
- Carbofuran
- Carbasone (CAS 536-99-2)
- Carfentrazone-ethyl
- Chloridan (aka pyrazon)
- Chloroherb.  
- Chlorpropham
- Chlorosulfuron
- Clethodim
- Clofopsam-id
- Clomazone
- Diclopyriel
- Diclopyyldin

#### 128 APPROVED Herbicide Substances
**Aimed at:-**

Detecting of the illegal use of prohibited substances.

Monitoring compliance with the specified MRLs for veterinary drugs, pesticides, mycotoxins, heavy metals etc.

Monitoring levels of environmental contaminants.

**Sampling focus:-**

Most samples (c. 80%) are taken in accordance with criteria designed to target animals or products, which are more likely to contain illegal residues.

However sampling may also be conducted in specific cases where the presence of illegal residues was suspected.
# National Residue Plan (Ireland) for Milk

## GROUP A – Substances having anabolic effect and unauthorised substances

| A1 | Stilbenes and derivatives |
| A2 | Antithyroid agents |
| A3 | Steroids (natural and synthetic) |
| A4 | Resorcylic acid lactones (incl. zeranol) |
| A5 | Beta-agonists |
| A6 | Compounds in Annex IV of Reg. 2377/90 (e.g. chloramphenicol, nitrofurans etc.) |

## GROUP B – Veterinary Drugs and Contaminants

| B1 | Antibacterial substances, incl. sulphonamides, quinolones, tetracyclines. |
| B2a | Anthelmetics (parasitic worms/helminths) |
| B2b | Anticoccidals |
| B2c | Carbamates and pyrethroids |
| B2d | Sedatives |
| B2e | Non-steroidal anti-inflammatory drugs (NSAIDs) |
| B2f | Other pharmacologically active substances (e.g. teflubenzuron, diflubenzuron) |
| B3a | Organochloride compounds (incl. PCBs) |
| B3b | Organophosphorus compounds |
| B3c | Chemical elements (lead, cadmium, mercury, arsenic) |
| B3d | Mycotoxins |
| B3e | Dyes (e.g. malachite green) |
| B3f | Others (brominated flame retardants, PAHs) |

Ref: National Food Residue Database  Report 2010/11. M. Danagher & J. Rae,
Analysis Challenges

The Level of Contamination

Food matrix complexity

Verification and validation
Requires demonstration of a quantitative relationship between intake of a substance and the amount of the substance or a metabolite in the body tissue or fluid of an animal - e.g., in blood, adipose tissue, urine, or milk.


- Involved measuring of the effect of the contaminant(s) rather than the more traditional single target compound concentrations
- Developed using rapid and efficient transcriptomics, proteomics and biosensor-based technologies
- Examples include detection of:
  - Pesticides
  - Mycotoxins such as produced by fungi
  - Therapeutic drugs (growth promoters, quinolone antimicrobials)
  - Endocrine disrupters (phytoestrogens)

Acknowledgement

Some concepts and illustrations used herein are based on a presentation entitled
FOOD SAFETY MANAGEMENT SYSTEM FOR CONTAMINANTS
AND DRUG RESIDUES IN THE DAIRY PRODUCTS
by Prof. Dr. Bruno LE BIZEC, École Nationale Vétérinaire,
Agroalimentaire et de l'Alimentation Nantes-Atlantique
given at the 2013 IDF World Dairy Summit in Yokohama, Japan.

However, the views and opinions expressed herein are my own and should not be taken as being those of Dr. LE BIZEC
and his co-workers.
THANK YOU