Meeting Emerging Food and Nutrition Safety Challenges

Anthony Huggett
Head of Quality Management
Nestlé
Largest Food & Beverage Companies

- 330,000 employees in over 150 countries
- 461 factories in 83 countries
- > 1 billion products sold every day

15 largest companies make up ~8% of world market.
Safe food depends on an increasingly complex and interdependent global food system

• Involvement and commitment of entire value chain

• Food must meet nutritional needs, be wholesome and tasty, and must be produced ethically respecting the environment and animal welfare

• Reports of food safety outbreaks and scares increase public awareness and decrease their confidence
The New Reality

- Digitalization
- Debt Crisis
- Resource scarcity

A fragile food resources balance, under growing structural pressure... reinforced by the interdependencies of energy, food and water.
Challenges of the New Reality

• Pressure on raw materials leading to increased risk of economic adulteration

• Increasingly sensitive, simple and affordable analytical methodologies enhanced by advances in data analysis

• Lack of regulatory standards or non-harmonised standards

• Increasing concern on food safety

• Instant globalisation of food safety issues through digital media
Food adulteration

- In 18th Century some bakers added potassium aluminium sulphate and chalk to the flour to whiten the bread.

- Frederick Accum, a German chemist, was the first to raise the alarm about food adulteration. “A Treatise on Adulterations of Food and Culinary Poisons” published in 1820.

Food Safety Endangered Worldwide by Increased Food Counterfeiting

BY DAN FLYNN | OCTOBER 25, 2012

In the Czech Republic recently, methanol put in alcohol resulted in 30 deaths.

Some fear higher world food prices are making food counterfeiting the next big global trend. Counterfeit food is a way to steal millions and put food safety at extreme risk.

Obviously, anyone willing to rip off valued brands or products to manufacture counterfeit food outside of any the regulation of any country does not give a rip about food safety.

Interpol Police have recently turned up candy bars, fish, cheese, and tomato sauce—all phony—foods that could have ended up in the U.S.
Identification and prevention of Adulteration

Melamine

• Targeted Adulteration

Two sentenced to death over China melamine milk scandal

China yesterday handed down death sentences to two men accused of responsibility for the tainted milk scandal which killed at least six babies and sickened hundreds of thousands of others.

By Richard Spencer in Beijing
Published: 2:29PM GMT 20 Jan 2009

The head of the country’s biggest milk powder company, Sanlu, was spared the
Adulterants of milk

- Melamine
- Cyanuric acid
- Formaldehyde, Formalin
- NaOH, KOH
- Chlorine
- Na azide
- Mercuric chloride
- K dichromate
- Chloroform
- Mineral oils
- Na carbonate
- Na bicarbonate
- Na thiocyanate
- Benzoic acid
- Sorbic acid
- Salicylic acid
- Hydrated lime
- Vegetable oil
- Leather protein

- Urine
- H₂O₂
- Water
- Salt
- Sugars
- Milk powders
- Collostrum
- Urea
- Ammonium salts
- Hydrolysed proteins
- Dicyanodiamide
- Vegetable oil
- Sweeteners
- Starch
- Flour
- Paper pulp
- Detergent
- Na omadine
- Na tripolyphosphate
- Trioxymethane
- Polypropylene powder
- Fertilizers

Likelihood

Safety concern
Analytical methods for detection of adulterants

Field
- Rapid tests

On-line
- Spectroscopy (XRF, Raman, NIR)
- Titration
- HPLC

Factory lab
- ELISA
- LC-MS/MS
- GC-MS
- ICP-MS

Regional lab
- U/HPLC
- MALDI
- TOF-MS

Simple & rapid

Complex & accurate
Untargeted Chemometric Fingerprinting to identify Milk Adulteration

Fourier Transform Infrared Spectroscopy

Cow’s milk (CM)

Ammonium sulphate (AS)
Untargeted Chemometric Fingerprinting to identify Milk Adulteration

Fourier Transform Infrared Spectroscopy

- Cow’s milk (CM)
- Ammonium sulphate (AS)
- CM + 0.15% AS
- CM + 0.3% AS
FTIR can detect when an adulterant has been added to the milk

Normal Milk

Melamine: 0.15%

Number of samples

ASM scores
FTIR can detect when an adulterant has been added to the milk.

Cyanuric acid: 0.15%

Cyanuric acid: 0.05%

Normal Milk
FTIR to detect Milk Adulteration

- Cyanuric Acid
- Melamine
- Fresh Milk
- Ammonium Sulphate
Untargeted Chemometric Fingerprint analysis for identifying adulterants in milk

Fourier Transform Infrared Spectroscopy

Able to check 10'000 farmers every week

Action:
- Audit farmer
- Perform more detailed analyses

MD ≤ 3.4

3.4 < MD < 5

MD ≥ 5

Intensive Monitoring

No Action

Action:
## Limit of Detection for adulterants in milk by FTIR

<table>
<thead>
<tr>
<th>Adulterant</th>
<th>LOD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine</td>
<td>0.15</td>
</tr>
<tr>
<td>Milk Powders</td>
<td>1.0</td>
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<tr>
<td>Urea</td>
<td>0.03</td>
</tr>
<tr>
<td>Maltodextrin</td>
<td>0.15</td>
</tr>
<tr>
<td>Flour</td>
<td>0.15</td>
</tr>
<tr>
<td>Sugar</td>
<td>0.15</td>
</tr>
<tr>
<td>Sweetener</td>
<td>0.15</td>
</tr>
<tr>
<td>Salt</td>
<td>0.15</td>
</tr>
<tr>
<td>Hair Protein</td>
<td>0.3</td>
</tr>
<tr>
<td>Leather protein</td>
<td>0.3</td>
</tr>
<tr>
<td>Pig skin protein</td>
<td>0.09</td>
</tr>
<tr>
<td>Whey</td>
<td>0.15</td>
</tr>
</tbody>
</table>

<table>
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</thead>
<tbody>
<tr>
<td>Melamine</td>
<td>0.03</td>
</tr>
<tr>
<td>Cyanuric Acid</td>
<td>0.03</td>
</tr>
<tr>
<td>(NH4)2SO4</td>
<td>0.03</td>
</tr>
<tr>
<td>Urea</td>
<td>0.03</td>
</tr>
<tr>
<td>KOH</td>
<td>0.15</td>
</tr>
<tr>
<td>Na2CO3</td>
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</tr>
<tr>
<td>NaHCO3</td>
<td>0.03</td>
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<tr>
<td>NaSCN</td>
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<tr>
<td>NaOH</td>
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</tr>
<tr>
<td>Demolder</td>
<td>0.3</td>
</tr>
<tr>
<td>Palm Oil</td>
<td>0.3</td>
</tr>
<tr>
<td>Pork Fat</td>
<td>0.15</td>
</tr>
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</table>
Raw Material Identity Confirmation with Handheld NIR

- NIR Scanning Monochrometers used to confirm identity of raw materials
- Can identify adulterated materials
Database of Adulterants launched by USP

Most adulterated ingredients

- Olive oil
- Milk
- Honey
- Saffron
- Orange juice
- Coffee
- Apple juice

Jeffrey C. Moore, John Spink, Markus Lipp. Journal of Food Science (2012) 77 (4), R118-R126
Need to understand and control the entire supply chain  “You must know your supplier’s supplier”
Potential hazards all along the supply chain
Multi-residue Analysis of Contaminants

Liquid chromatography
- High sensitivity
- High specificity
- Confirmatory
- Screening limited

Gas chromatography
- Easy to handle
- Confirmatory
- Screening limited
- Lower sensitivity

GC-MS
+ High screening capacity
+ High specificity
- Lower sensitivity

GC-TOF
+ High specificity
+ High sensitivity

GC-MS/MS
+ High sensitivity
+ More complex

LC-QqQ
+ High screening
+ High specificity
+ Confirmatory
- Lower sensitivity
- Cost
September 2011 – Health scare in USA due to reports of Arsenic in Apple Juice from China

- Levels of arsenic in apple juice exceeded US drinking water standard
- Called for FDA to set limits for arsenic in fruit juice
Sep 9, 2012: Pediatrician says Kids should avoid rice until FDA issues standards.

Reported arsenic levels in rice prompt concern

(CBS News) Consumer Reports found significant levels of arsenic in apple juice earlier this year, and now, the magazine has a new study, showing many brands of rice also contain the toxin.

The arsenic enters into the rice when it is grown, according to Dr. Philip Landrigan, a pediatrician at New York’s Mount Sinai School of Medicine. He explained the rice with the highest levels of arsenic is from Texas and Louisiana, and along the Gulf coast where fields were used to grow cotton a century ago.

Asked about the difference between his statements that warn against rice and the FDA’s that do not, Landrigan said, "(The FDA) are doing the right thing by saying they are doing a study and they will get there. In the meantime parents, grandparents, consumers have to be intelligent. ... I'm a pediatrician dealing with parents and babies one at a time. And the advice I'm going to be giving parents in my practice is avoid rice."
We need regulatory limits for some contaminants and residues

- Increasing use of progressively more sensitive analytical techniques

- In the absence of regulatory limits, any detectable level of a chemical or microbiological contaminant is considered a safety concern by the consumer
May 2011: Outbreak of STEC in Germany

Over 3,000 cases of illness and 47 deaths

The O104:H4 strain of STEC is a rare, highly virulent serotype having an unusual combination of pathogenic factors causing hemolytic uremic syndrome.
The cause of the outbreak was correctly identified in July 2011

May 2011: Cucumbers from Spain

July 2011: Fenugreek seeds from Egypt
“We know statistically that food is safer than it’s ever been, but consumers don’t perceive that as the case”

Poll Shows Food Safety Confidence Slightly Decreased This Year

BY JAMES ANDREWS | OCTOBER 29, 2012

U.S. citizens are slightly less confident in the safety of the food supply compared to recent years, according to annual polling conducted by the Center for Food Integrity.

As part of the CFI’s annual study tracking attitudes toward the food supply over time, the organization asked respondents a series of questions about food prices, animal welfare, sustainability, world food stocks, and U.S. food safety. Responses to statements were given on a scale of 0 to 10, ranging from “Strongly Disagree” to “Strongly Agree.”

To the statement, “I am confident in the safety of the food I eat,” respondents answered with a mean of 5.99, down from 6.32 last year. That response, however, is still higher than the 5.64 reported in 2007, the first year
All stakeholders have a role to play in safeguarding consumer trust

Transparency is essential:

• Where there is no food safety issue we must reassure consumers

• Where there a real food safety issue we must create awareness and take immediate action

• The absence of communication is filled by rumour and fear
Summary

- Understand and control the entire supply chain
- Chemometric fingerprinting to prevent and detect adulteration
- Increasing use of sensitive analytical techniques is highlighting the need for regulatory limits
- Transparent accurate communication is essential to maintain consumer trust
- Understand and manage the impact of new media