**DEFINITION OF FOOD FRAUD**

Food fraud is a collective term used to encompass the deliberate and intentional substitution, addition, tampering, or misrepresentation of food, food ingredients, or food packaging; or false or misleading statements made about a product, for economic gain.

**FOOD RISK MATRIX**

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<tbody>
<tr>
<td>Gain: Economic</td>
<td>Food Fraud(1)</td>
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<td>Public Health, Economic, or Terror</td>
<td>Leading EMA Incidents by Food Ingredient Category (1980 to 2013) NCFPD EMA Incident Database</td>
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**Leading EMA Incidents**

Leading EMA Incidents by Food Ingredient Category (1980 to 2013)

Source: Compiled by NCFPD CRS from records in the NCFPD EMA Incident Database (database accessed November 14, 2013) and based on 302 reported incidents. These incidents were also reported by A. Kircher, “Building Capabilities to Find and Mitigate.” Presentation at the USP Workshop of Economically Motivated Adulteration of Food Ingredients and Dietary Supplements, September 26–27, 2013.
**Common Examples of Food Fraud**

SOURCE: 2015 Czech Food Fraud Brochure

**Challenges of Food Fraud**

- Food Fraud is a growing trend but quantifying the economic or public health impact of food fraud is difficult.
- Historical incidents and quantitative analysis are used to identify emerging risk to create early warning systems.
- Creative Fraudsters seems to constantly evolve, to evade the most recent detection hurdles.
- Targeted Screening methods typically used in food laboratories are inadequate as most adulterants are unknown.
- Regulatory Framework

**Beyond Instrumentation**

**Analytical Workflow Solutions**

- Sampling
  - Sample collection products
  - Portable analyzers
  - Culture media solutions
- Sample Preparation / Introduction
  - Laboratory equipment and consumables
  - High-purity solvents for analytical instruments
  - Sample Preparation, ASE, QuEChERS, SPE, TD etc.
- Sample Analysis
  - Analytical instruments, consumables and reagents
- Data Management
  - LIMS and data management software
  - Traceability of lab data, methods, training records
Analytical Challenges and Approaches of Food Fraud

**Case Study 1 – Virginity Testing – the Olive Oil Method**

**WHY?**
- EVOO is prized for its taste and beneficial levels of mono-unsaturated fatty acids
- Consumer demand is rising above production levels

**WHY TEST?**
- Potential Allergens or non-food grade materials leads to Food Safety Concerns

**CHALLENGE –**
- Adulteration with lower quality ingredients can be hard for both consumers and food inspectors to detect

**Analytical Approach**
- UltiMate 3000 UHPLC+ Systems
- High Performance Liquid Chromatography (HPLC) with Charged Aerosol Detection (CAD)
  - Allows Characterization of the triglyceride (TAG) of oil samples showing the different TAG profiles in pure EVOO and product adulterated with corn, hazelnut or pomace oil
  - Principal Component Analysis (PCA) easily highlights the differences in the chromatograms, allowing discrimination between pure and adulterated samples according to TAG clusters

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**Case Study 2 - Which Udder? High Resolution Mass Spectrometry for Authenticating the Source and Quality of Dairy Products**

**WHY?**
- Certain types of milk are classed as premium

**WHY TEST?**
- Dairy is an important food group for vulnerable sectors of the population – the elderly, infant and pregnant women
- Ensuring species of origin and freedom from potentially toxic adulterants is vital to maintain consumer confidence and health
- Public health threat – risks hypersensitive reaction, death

**CHALLENGE –**
- Diverse Areas of Testing Required – Species of Origin and Presence of Additives

**Analytical Approach**
- Hrbek and co-authors assessed HRAM LC/MS on 3 areas of testing –
  - species of origin;
  - difference between organic and conventional milk
  - use of non-dairy adulterants
  - Extracting triacylglycerals (TCA) from milk with Methanol or Toluene, centrifuge and analyze the unique species –specific TCA profiles by DART-HRAM LC/MS
  - Showed good discrimination between three different specifies
  - Soft cheese samples spiked with vegetable oils; 1% adulteration can be detected as TAG profiles of vegetable oils and bovine milk differ significantly

**Analytical Challenges and Approaches of Food Fraud**

**Case Study 3 - EA-IRMS: Detection of Honey Adulteration**

**WHY?**
- Honey is subject to fraud by adulteration with low price invert sugar syrups.

**CHALLENGE –**
Saccharides in syrups derived from cane, corn or beet sugar are difficult to distinguish from those in pure honeys.

**ANALYTICAL APPROACH –**
- Sample extraction according to AOAC 998.12 Guideline
- Sugar cane and corn syrups have distinctive isotopic 13C signatures (C4 photosynthetic pathway vs to most honey which is derived from plants that use the C3 photosynthetic pathway)
- These differences in 13C isotopic composition allow detection of >7% addition of such sugars
- Stable isotope analysis of honey can be undertaken with an EA-IRMS System

**Case Study 4 - Japanese Eel: Bringing Science to the Front Lines to Deter Fraud**

**WHY?**
- Over-fishing and difficulties with raising juveniles led to shortages and higher price of Japanese eel

**CHALLENGE –**
With the naked eye, it can be difficult, if not impossible, to discern the difference between Japanese eel and an inferior imported eel

**ANALYTICAL APPROACH –**
- Shizuoka Institute of Science and Technology developed a method to simultaneously test small tissue samples from within batches that contain thousands of eels.
- If DNA from a nonindigenous eel is detected in a batch, the entire batch can be isolated and further testing can be done
- Good deterrent for mislabeling of the origin of the country

**COMPLEMENTARY HEALTH PRODUCTS**

- **Heavy Toxic Metals**
- **Adulteration of western drugs**
- **Toxic alkaloids**
- **Authentication of herbal materials**
- **Aflatoxins**
- **Pesticides**

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Continuing Challenge for Food Fraud

- Food Fraud is constantly evolving and there will always be different challenges facing regulatory bodies, food manufacturers and food testing laboratories.
- Common food fraud cases include fish and seafood, beverages, oils, honey etc.
- Food Testing Laboratories need to be kept up to date with the latest Food Fraud cases to be prepared for testing requirements.
- There are challenges in the analytical approaches to detecting Food Fraud which can be addressed with latest instrumentation and technologies.

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Thank you very much!

For more details please contact: ruby.ong@thermofisher.com