Challenges in Monitoring for Food Adulteration

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Agenda

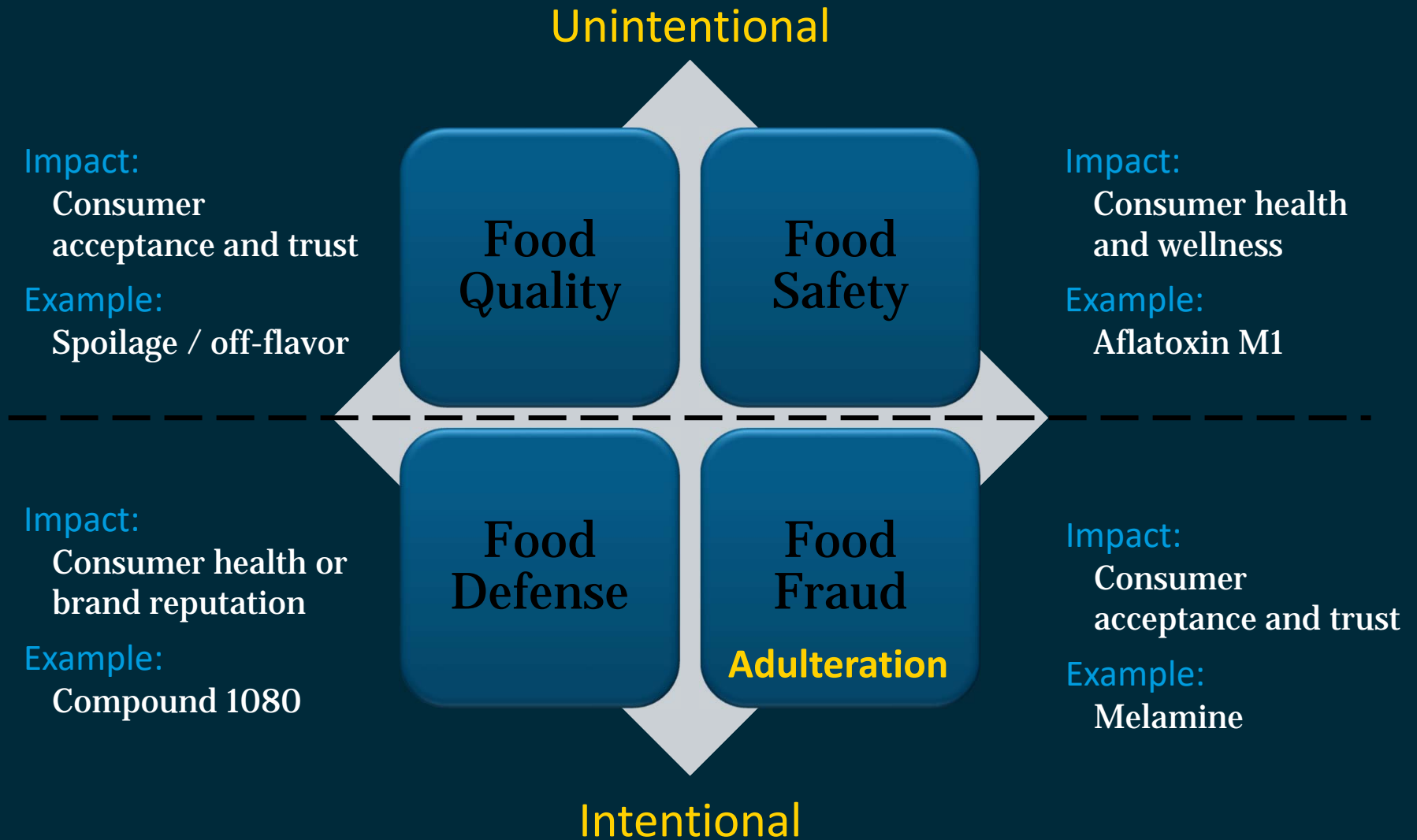**Defining Food Adulteration**

Manufacturer's Overview

Analytical Puzzle

Methodologies for Food Adulteration

Defining Analytical Workflow

Food Safety Issues - Definitions

Unintentional

Impact:
Consumer acceptance and trust

Example:
Spoilage / off-flavor

Food Quality

Food Safety

Impact:
Consumer health and wellness

Example:
Aflatoxin M1

Impact:
Consumer health or brand reputation

Example:
Compound 1080

Food Defense

Food Fraud

Adulteration

Impact:
Consumer acceptance and trust

Example:
Melamine

Intentional

Adapted from: J. Spink and D.C. Moyer, "Defining the Public Health Threat of Food Fraud," *Journal of Food Science*, 2011
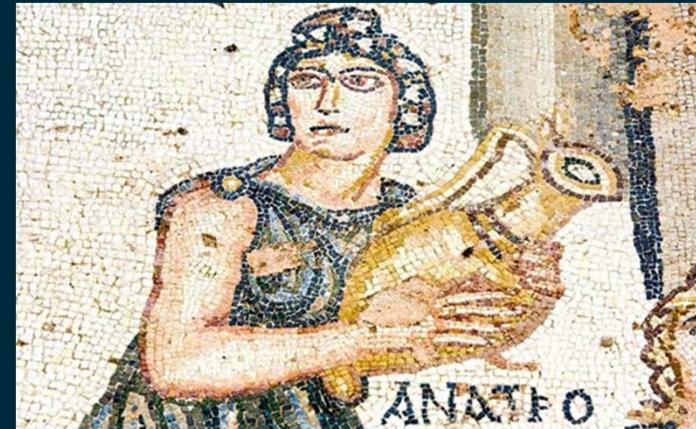
Food Adulteration

Ancient problem with many names

- Food Adulteration
- Food Fraud
- Economic Adulteration

Paradigm shifted in 2008

- Melamine

Motivation is economic

- Increase apparent economic value
- Dilution / Substitution / Addition

Never underestimate the creativity of motivated fraudster!

Abbott Nutrition:
Nutritional Products in Three Broad Categories

Pediatric	Adult / Medical	Active Living
• Expectant Mother • Infant Formula • Growing Up Milk • Toddler	• Supplemental Nutrition • Disease Specific • Hospital Patient	• Active & Healthy Lifestyle • Sports & Fitness Enthusiast

Supply chain complexities

Global Distribution

Analytical Complexity

- Global supply and distribution networks
- Multiple ingredient and product combinations
- Regulatory requirements not harmonized

>5,000 Individual SKU's
- Liquid, Powder, and Solid Food Products
- Multiple flavors

>2,000 Commodities
- >200 Dairy Ingredients

>100 Methods at TPL's
- Nutrients
- Food Safety

12 Nutrition Manufacturing Sites
- In-Process Testing
- Release Testing

Global Supply

Simplification Strategies

- Method harmonization across global lab network
- Align internal test requirements with most stringent global requirements
- Group similar ingredients and products for risk assessment and method validation

Food Adulteration – Risk based strategies

Ingredient

- Susceptibility
- History
- Supply chain
- Monitoring methods

Supplier

- Quality performance
- Audit History
- Relationship

Economic

- Commodity pricing

The Analytical Puzzle

Putting the pieces together

- Clearly defining requirements
- Balancing speed with accuracy and specificity
- Maintaining instrumentation and trained personnel
- Modifying methods and strategies to meet changing demands

Solutions are not one size fits all

- Analytical requirements and solutions can vary depending on local requirements, product type, and supply chain needs


Protein · HPLC · Regulatory Limits · Third Party Labs · Allergens · Minerals · Heavy Metals · Sugars · GC · Central R&D · FTIR · Supplier Labs · Plant Labs · Quality Specs · Veterinary Drugs · Fat · LC-MS · Novel Ingredient · Vitamins · Process Analytical Technology · Pesticides · Customer Queries

Testing Strategies

Targeted screening

- Known target compounds
- Reliable identification
- Quantitative

Examples

- LC-MS/MS
- GC-MS

Sensitivity

Selectivity   Speed
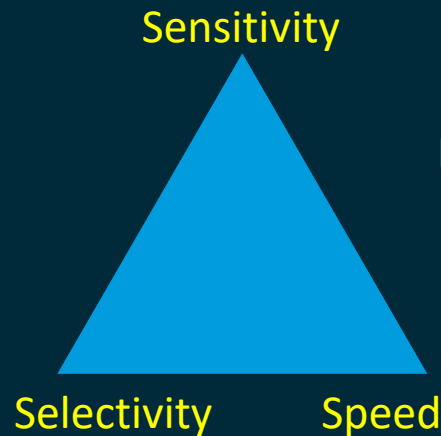
Non-Targeted screening

- Universal detection
- Sample Profiling
- Unknown adulterants

Examples

- Spectroscopy (Infrared or Raman)
- NMR

Targeted Method
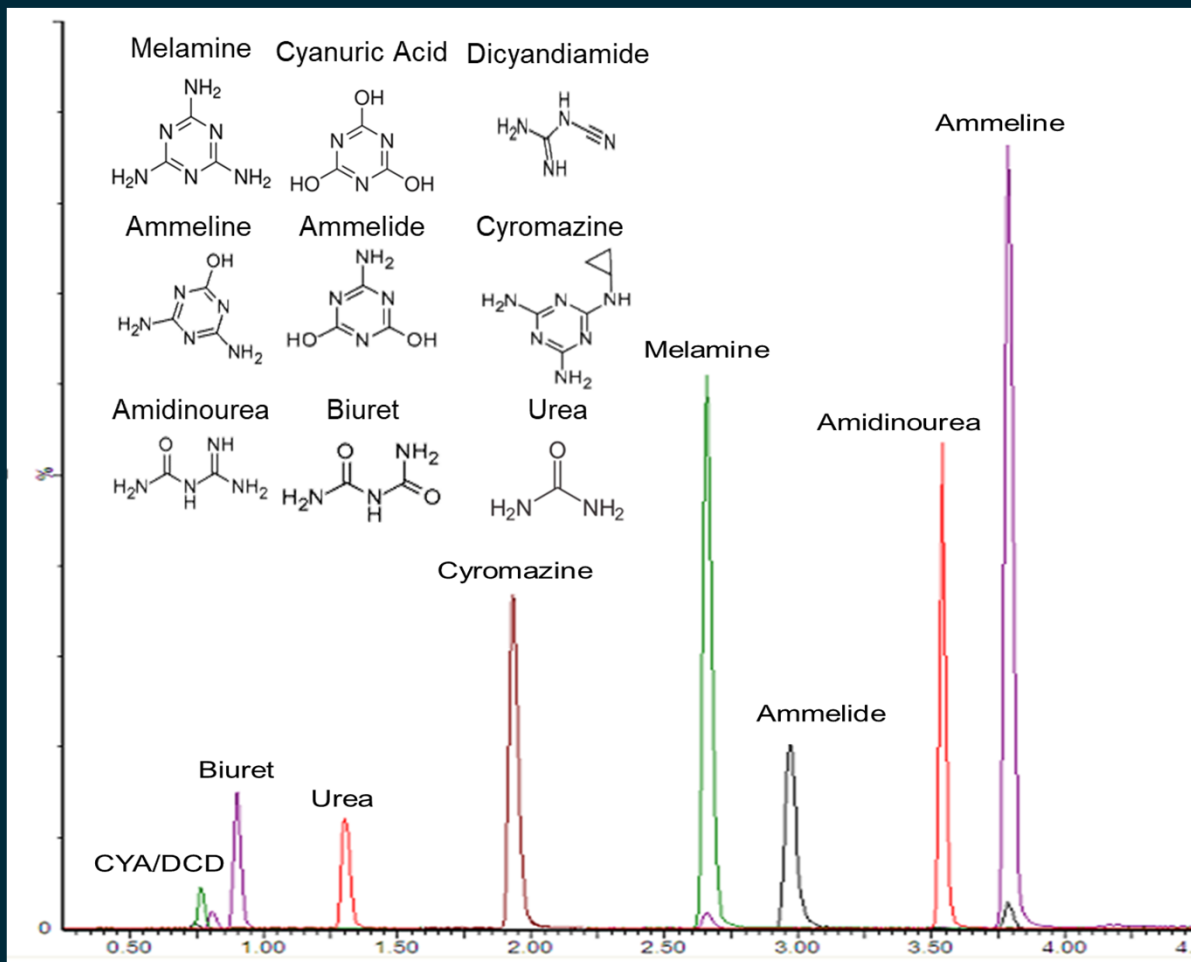
Sample Preparation

- Dilute & Shoot

Analysis

- UPLC-MS/MS
- 5 min analysis

Performance

- Estimated LOD 0.1 – 8 mg/kg
- Broad applicability
- Very rugged

Limitations

- Sample Prep
- Complex instrument

Protein Adulterants by LC-MS/MS

Non-Targeted Method

Sample Preparation

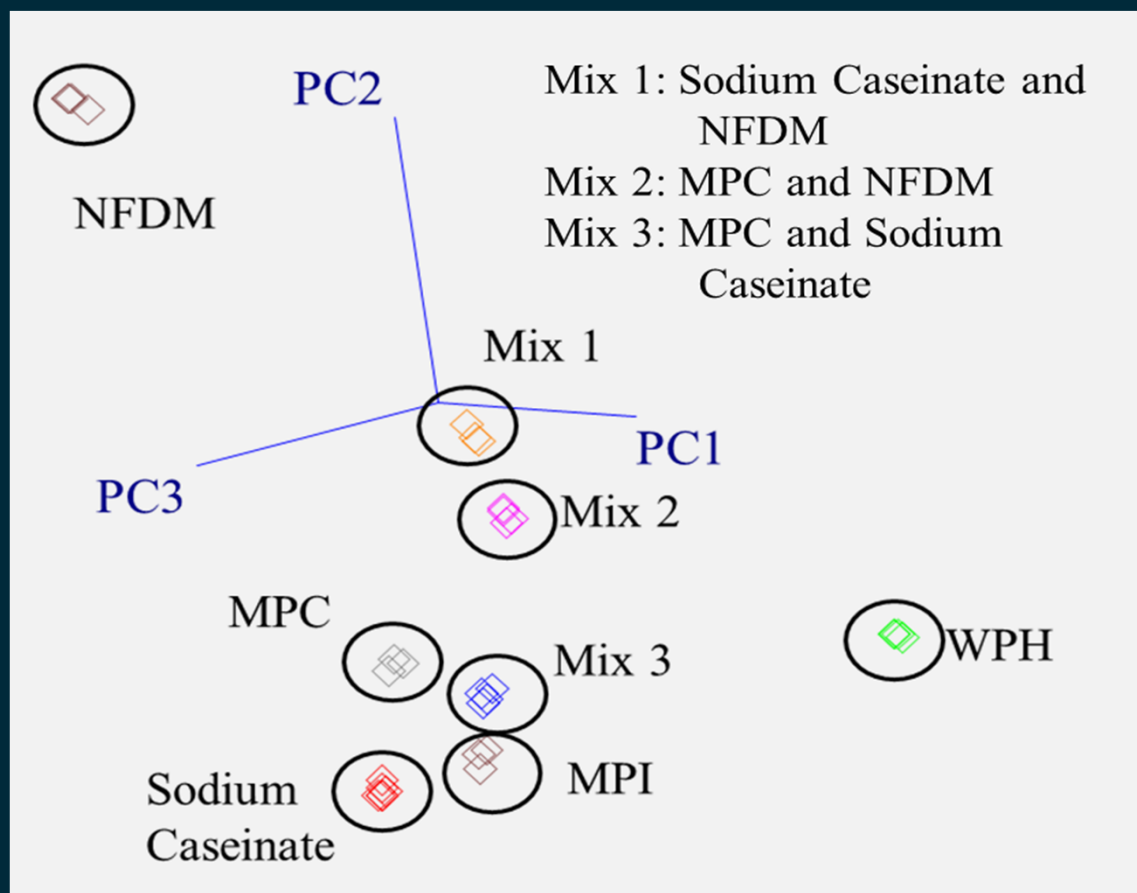- None

Analysis

- ATR-IR
- <1 min analysis

Performance

- Accurate classification
- Reliable exclusion of mixtures

Limitations

- Sensitivity
- Robustness

Classification of Milk Proteins - Infrared Spectroscopy

Non-Targeted Method

Sample Preparation
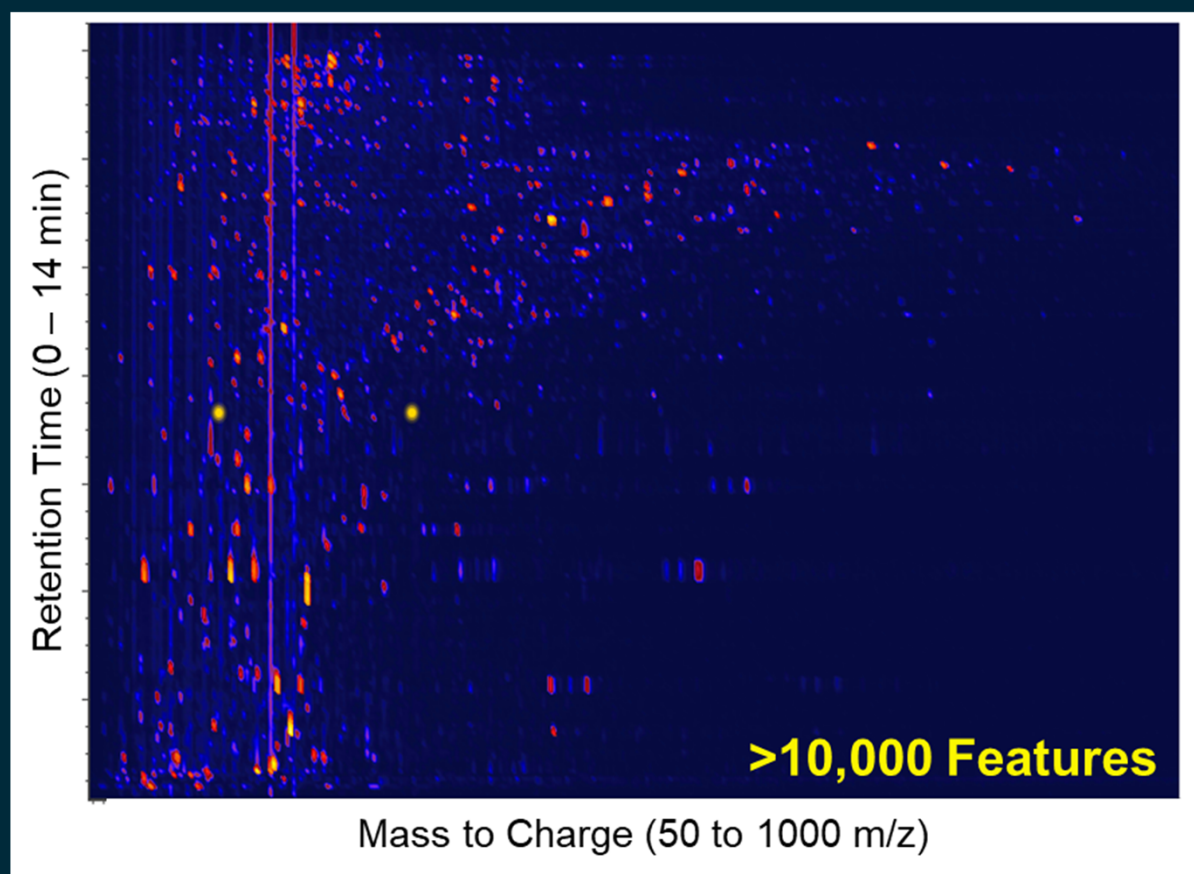
- QuEChERS
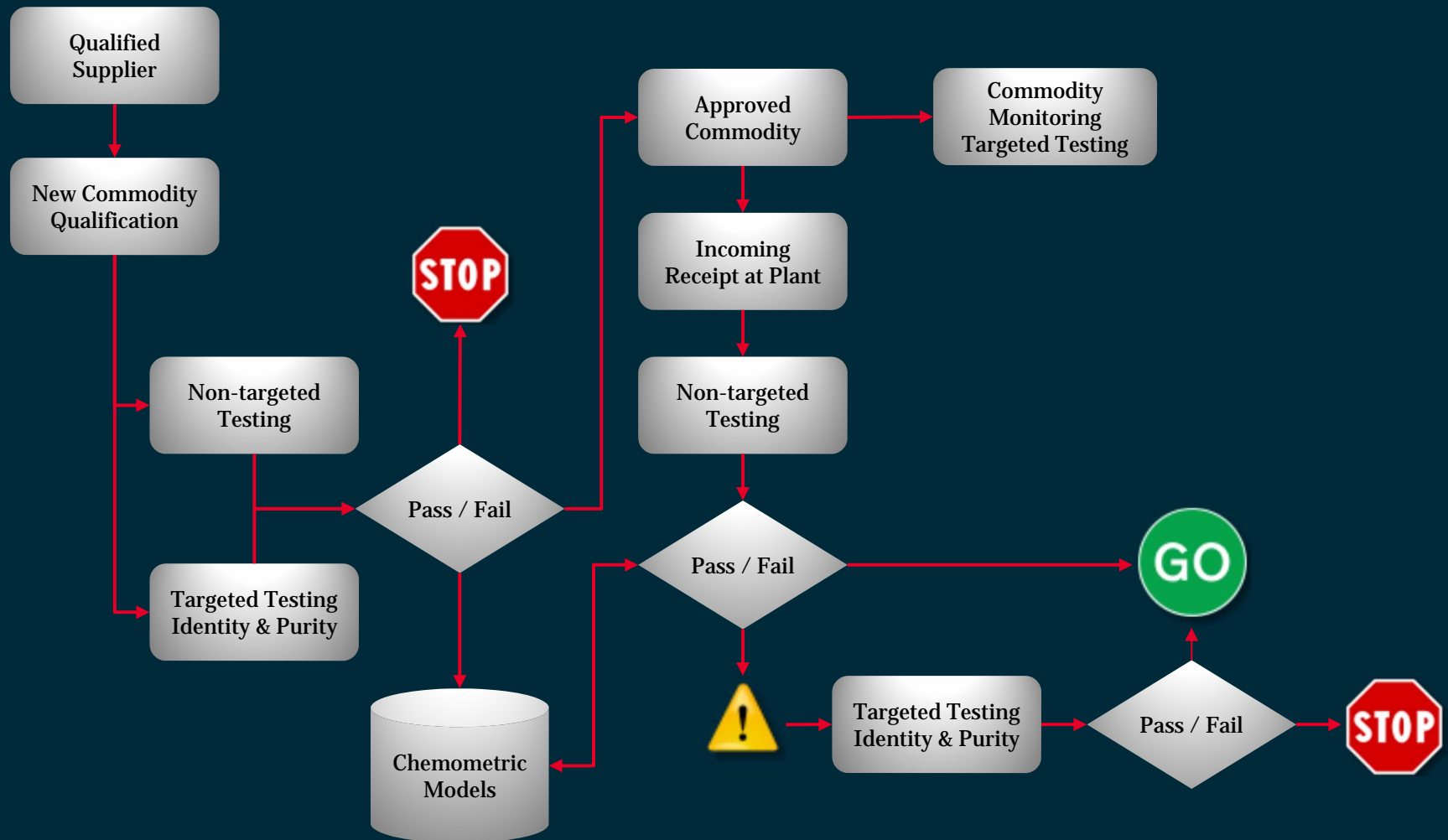
Analysis

- UPLC-QTOF MS
- 15 min analysis

Performance

- Failure rate:

  ~10% False Negative

  <2% False Positive

Limitations

- Sample prep
- Complex instrument
- Data review

Milk Proteins by Accurate Mass LC-MS

>10,000 Features

Retention Time (0 – 14 min)

Mass to Charge (50 to 1000 m/z)

Example Workflow:
Non-targeted / Targeted Methods

Conclusions

Change is inevitable and continuous

Be intentional
- Update risk assessment
- Monitor external environment

Be creative
- Anticipate potential risk
- Tailor solutions to the problem

Communicate
- Supply chain monitoring
- Challenge internal systems

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Thank You!