How Advanced Targeted and Non-Targeted Testing Can Help You Detect Food Contaminants, Residues and Adulterants

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● Reading, UK ● Singapore

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Outline

▶ About Covance Food Solutions

▶ Overview of capabilities and challenges
in chemical food safety testing

▶ Selected targeted state-of-the-art methods

▶ Non-targeted analysis testing

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About Us

COVANCE

CRO with >12,500
employees
in over 60 countries
Division of LabCorp®
(>48,000 employees)

FOOD SOLUTIONS

Delivering solutions
for the life cycle of
product

Food industry
Dietary supplement industry
Infant formula industry

CONCEPT → DEVELOPMENT → LAUNCH → QUALITY PROGRAMS → BRAND PROTECTION

Public

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Design and Integrity

Product Design

Idea Generation

Culinary Services

Product and Process Development

Consumer Research

Sensory Evaluation
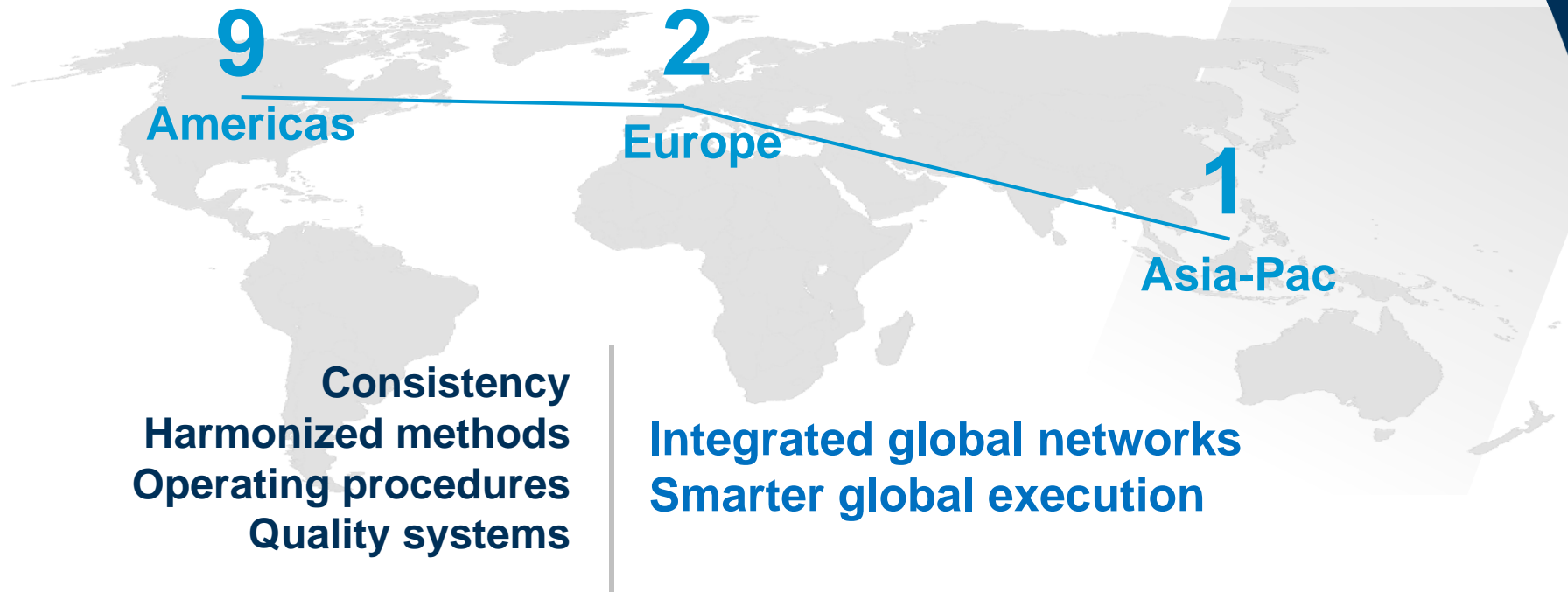
Regulatory Considerations

Commercialization and Scale-Up

Product Integrity

Nutritional Chemistry Solutions

Microbiological Safety

Contaminants/Residues

Allergens

Adulterants

Risk Assessments

Challenge Studies and Process Validations

Shelf-Life and Stability Testing

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Integrated Global Network

GLOBAL CONSISTENCY: LABORATORY TO LABORATORY

Providing insights regarding local and regional regulations

9
Americas

2
Europe

1
Asia-Pac

Consistency
Harmonized methods
Operating procedures
Quality systems

Integrated global networks
Smarter global execution

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Ensuring Product Chemical Safety

- Pesticide residues
- Veterinary drugs
- Mycotoxins
- Processing contaminants
- Allergens
- Polycyclic aromatic hydrocarbons
- Polychlorinated biphenyls / dioxins
- Heavy metals
- Adulterants

REGULATION COMPLIANCE

BRAND PROTECTION

CONSUMER PROTECTION

ECONOMIC ASPECTS

Public

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Challenges in Routine Food Safety Testing

DRIVEN BY CLIENT EXPECTATIONS

All relevant matrices

Ingredients
Finished products

Competitive price

Acceptable cost

Results on time

Fast turn-around times

Correct results

Accurate quantification and identification
Compliance with regulation and industry standards

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Pesticide Residue Analysis

> 1600 parent compounds
(and metabolites, degradation products and impurities)

Method performance requirements
(trueness, precision, identification)

Regulation
(MRLs, tolerances)

EU
DIR

Saf
Pes

Guidance document on ana
for pesticides residues analysis in food and feed.

SANTE/11945/2015

Single residue methods

REGULATION (EC) NO 396/2005 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on maxim   f plant and animal origin and

Multi-residue methods

COMMISSION DIRECTIVE 2006/141/EC
of 22 December 2006
on infant formulae and follow-on formulae and amending Directive 1999/21/EC

COMMISSION DIRECTIVE 2006/125/EC
of 5 December 2006

Multi-analyte methods with simultaneous quantification identification using GC-MS and LC-MS

processed cereal-based foods and baby foods for infants and young children
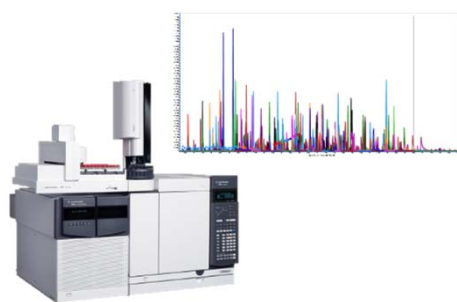
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Pesticide Residue Analysis

CFS METHOD

▶ 500+ pesticides, metabolites & degradation products

▶ Reporting limit of 0.01 mg/kg for most analytes/matrices

▶ Compliant with SANTE document requirements

▶ Covers SANTE commodity groups including difficult samples

▶ Unbiased quantification and extensive QC measures
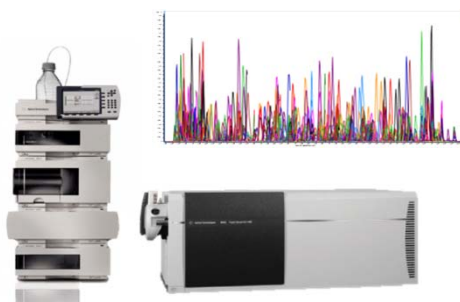
LC QQQ

GC QQQ

Images used with permission from Agilent Technologies

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Pesticide Residue Analysis

CFS METHOD

Streamlined sample preparation

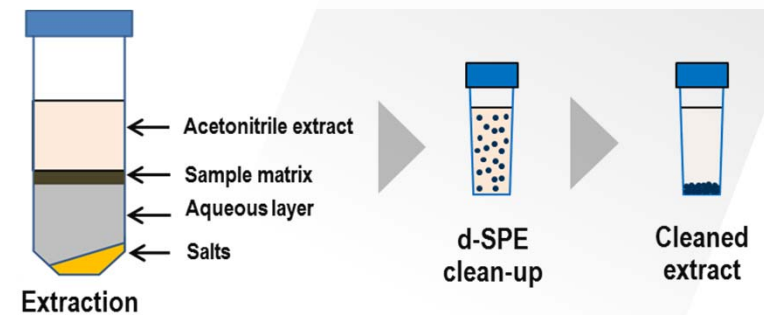High confidence identification

High-throughput

QuEChERS

(Q)uick
(E)asy
(C)heap
(E)ffective
(R)ugged
(S)afe

Acetonitrile extract
Sample matrix
Aqueous layer
Salts

Extraction

d-SPE clean-up

Cleaned extract

Official Methods of Analysis, AOAC Official Method 2007.01, Pesticide Residues in Foods by Acetonitrile Extraction and Partitioning with Magnesium Sulfate, AOAC INTERNATIONAL

CEN Standard Method EN 15662: Food of plant origin - Determination of pesticide residues using GC-MS and/or LC-MS/MS following acetonitrile extraction/partitioning and clean-up by dispersive SPE - QuEChERS method.

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Pesticide Residue Analysis

CFS METHOD

Streamlined sample preparation

High confidence identification

High-throughput

GC-MS/MS (~290 analytes)	BOTH (~235 analytes)	LC-MS/MS (~460 analytes)

Analyte overlap across platforms

Triggered-MRM algorithm

Elimination of false positive/negative results
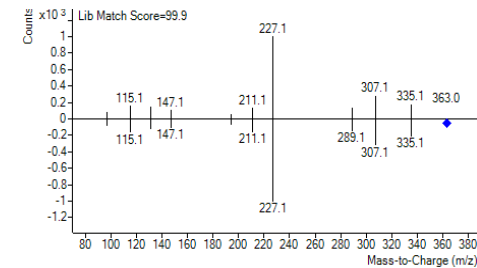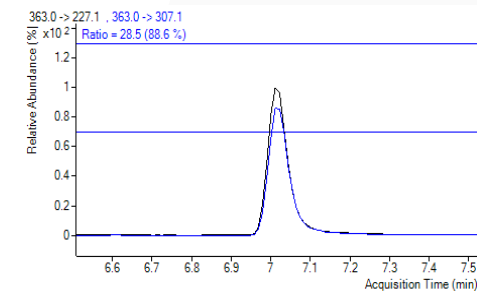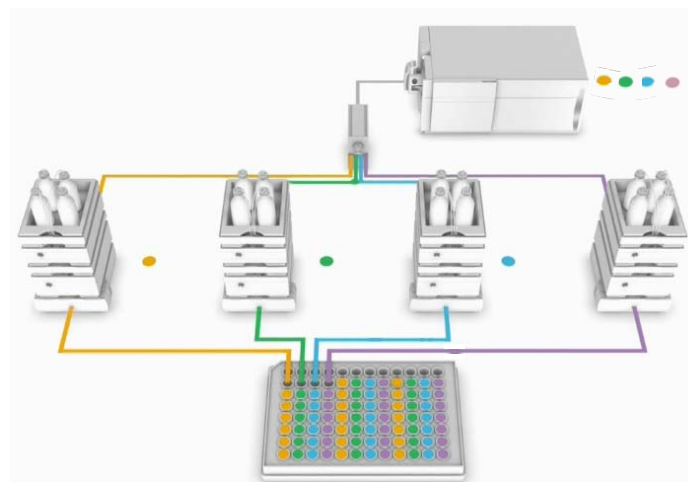
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Pesticide Residue Analysis

CFS METHOD

Streamlined sample preparation

High confidence identification

High-throughput

LC-MS system with 4 LCs and single MS

Up to four times higher throughput (elimination of MS instrument downtime)

Intelligent LC error handling (elimination of re-work)

Automated software tools (coordination, batch submission)

Image used with permission from Agilent Technologies

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Allergens

▶ **Over 150 million people suffer from allergies worldwide**

▶ **EU regulation requires to provide allergy information on food**

Ingredients: Granola (whole grain rolled oats, brown sugar, crisp grain rolled wheat, soybean oil, whole wheat flour, sodium bicarb rice crisp (whole grain brown rice, sugar, malted barley flour, salt) syrup, semisweet chocolate chips (sugar, chocolate liquor, cocoa (sugar, palm kernel and palm oil, partially defatted peanut flour, salt, vanillin [artificial flavor]), oligofructose, polydextrose, glyce sugar, calcium carbonate, salt, soybean oil, natural and artificial

**CONTAINS WHEAT, PEANUT, SOY AND MILK INGREDIENTS.
MAY CONTAIN TRACES OF TREE NUTS.**

*Sugar Content (on 40 gram basis): Regular Peanut Butter Chocolate Chip Quak

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Allergens

► **Enzyme-linked immunosorbent assay (ELISA)**

► **Polymerase chain reaction (PCR)**

► **LC-MS/MS**

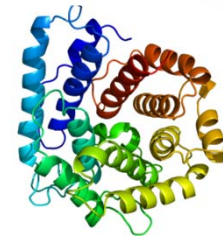| ELISA	PCR	LC-MS/MS
Quick & Simple **One allergen at a time** **False positive/negative results**	**Sensitive** **Can be multiplexed** **Food matrix interferences** **False negative results** **(processed foods)**	**Specific & sensitive** **Can be multiplexed** **Less susceptible to problems** **relating to food processing** **Accurate quantitation**

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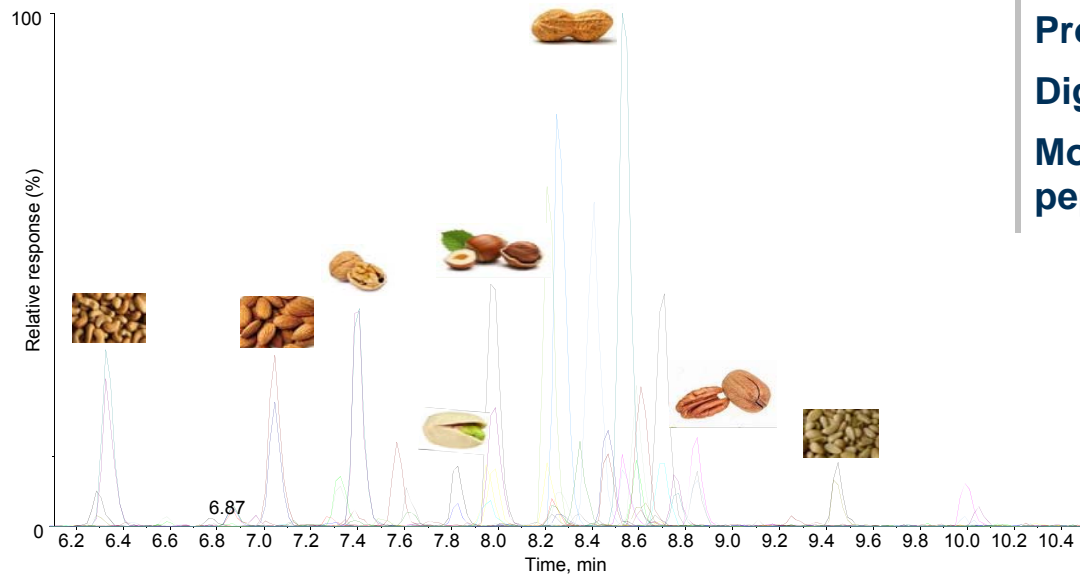
Allergens

▶ **Enzyme-linked immunosorbent assay (ELISA)**

▶ **Polymerase chain reaction (PCR)**

▶ **LC-MS/MS**

Agilent 1290 LC and 6495 QQQ

Protein extraction

Digestion

Monitoring of characteristic peptides

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Targeted and Non-Targeted Testing

PROVIDE ANSWER TO DIFFERENT QUESTIONS

Targeted analysis	Non-targeted analysis
Is it in the sample?	What is in the sample?

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Targeted and Non-Targeted Testing

TARGETED VS. NON-TARGETED

Targeted analysis		Non-targeted analysis
Well defined list of target analytes of interest	**Analytes**	Analytes not defined, all sample components are of potential interest
Available	Reference standards	Not available
Sample extraction and clean-up to remove sample matrix	Sample preparation	Generic extraction, minimum sample clean-up
Analyte-specific data recording conditions	Data recording conditions	Generic data recording conditions
Well defined characteristics for data processing	Data Processing	Data-mining followed by chemometric analysis

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Non-Targeted Testing

ANALYTICAL PLATFORMS

LC-(HR)MS

GC-(HR)MS

NMR Spectroscopy

IR Spectroscopy

Chemical 'fingerprint' of the sample

Gaining comprehensive insight into the composition of the sample is a challenging task

Multiple techniques are usually required to capture (food) sample fingerprint

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Non-Targeted Testing

ANALYTICAL PLATFORMS
CFS CAPABILITIES

LC-(HR)MS

GC-(HR)MS

NMR Spectroscopy

IR Spectroscopy
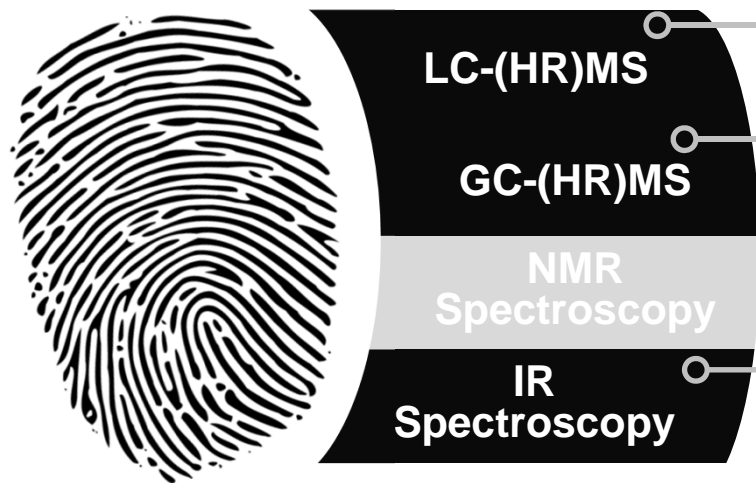
Chemical 'fingerprint' of the sample

Ultimate 3000

Q Exactive Plus

Agilent 7980 GC **7000C QQQ**

PerkinElmer Frontier IR

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Non-Targeted Testing

WORKFLOW

I. RECORDING OF SAMPLE FINGERPRINTS

▶ Relevant sample set

▶ Sample preparation

▶ Quality of the data

▶ Reproducible measurements
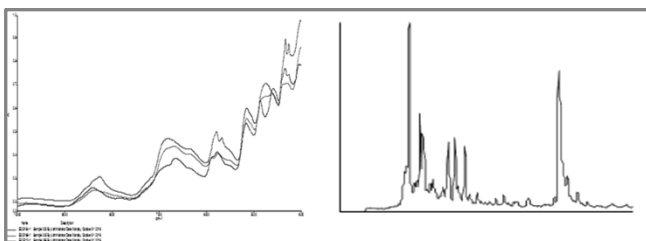
IV. IDENTIFICATION OF FEATURES OF INTEREST

▶ HR MS/MS and NMR data

▶ Spectral databases & interpretation software

▶ Unequivocal identification based on analysis of reference standard

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Non-Targeted Testing

APPLICATIONS

▶ Screening for emerging contaminants, residues and packaging migrants

▶ Detection of unexpected adulterants and classification model-based authenticity assessment

▶ Discovery of quality markers and active compounds

▶ Monitoring of chemical changes associated with food processing

▶ And other…

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Non-Targeted Testing

EXAMPLE APPLICATION
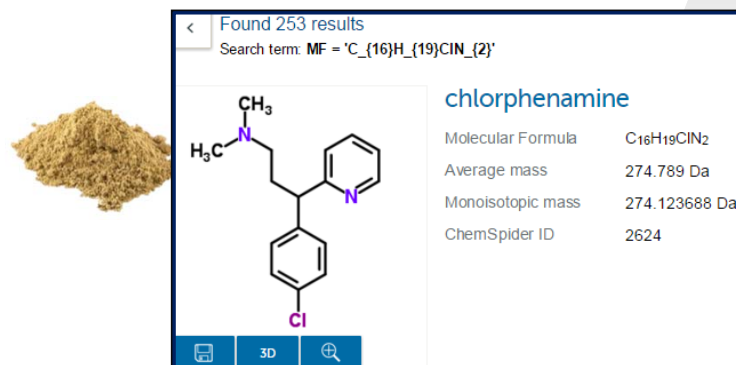
Quality control of batches of botanical ingredient using LC-HRMS fingerprinting

Recording of LC-HRMS fingerprints

Data-mining and chemometric analysis to highlight differences between past and new batches

Identification of unknown component based on chromatographic and spectral characteristics

Identity confirmation based on analysis of reference standard

Found 253 results
Search term: MF = 'C_{16}H_{19}ClN_{2}'

chlorphenamine

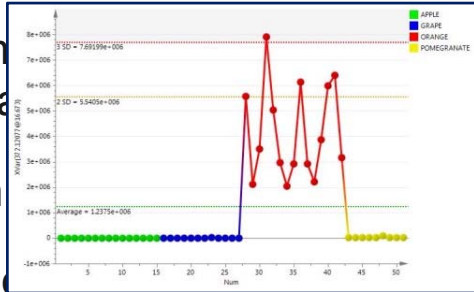| Molecular Formula	$C_{16}H_{19}ClN_2$
Average mass	274.789 Da
Monoisotopic mass	274.123688 Da
ChemSpider ID	2624
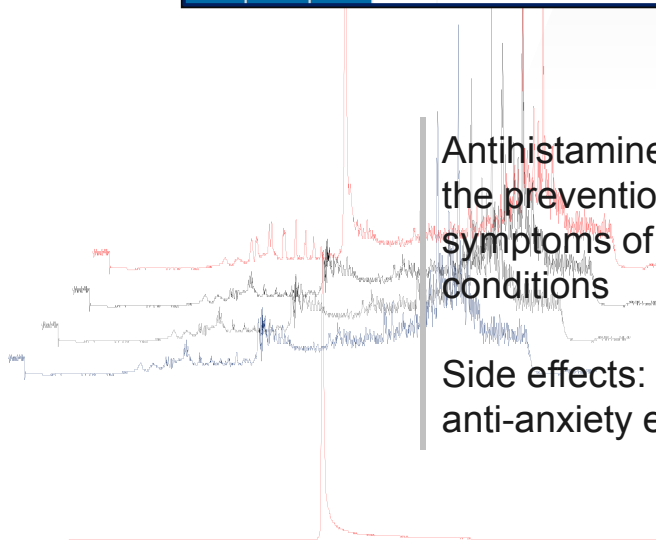
Antihistamine drug used in the prevention of the symptoms of allergic conditions
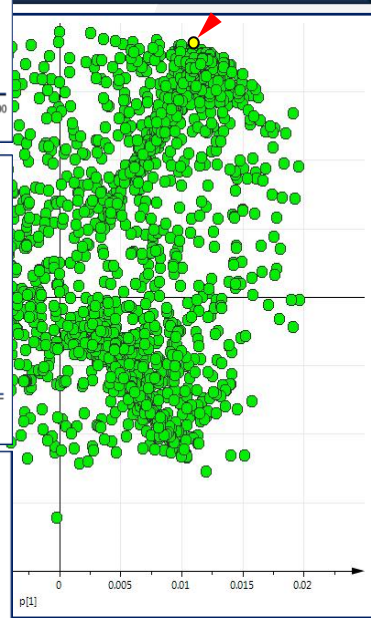
Side effects: drowsiness and anti-anxiety effect

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Non-Targeted Testing

EXAMPLE APPLICATION

Econom
adultera

Dilution

Extensi
juice wi

Public

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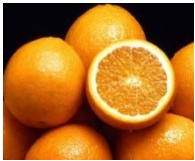**SOLUTIONS MADE REAL®**
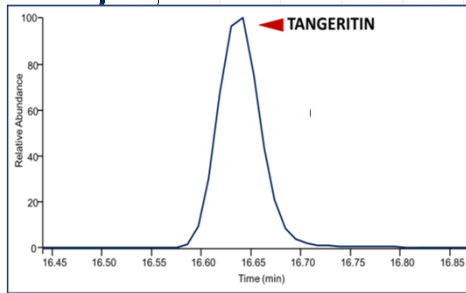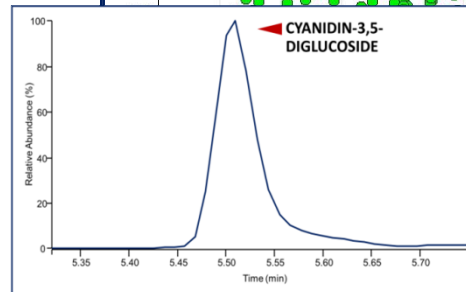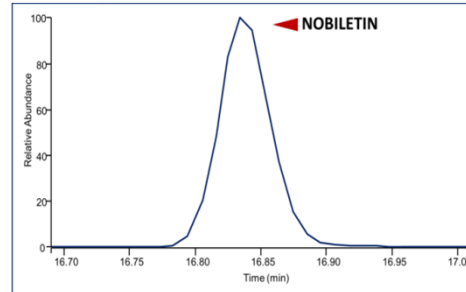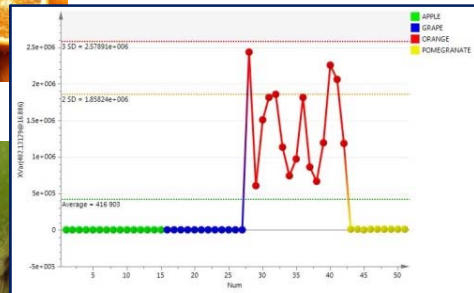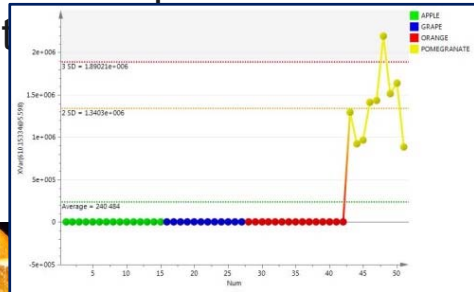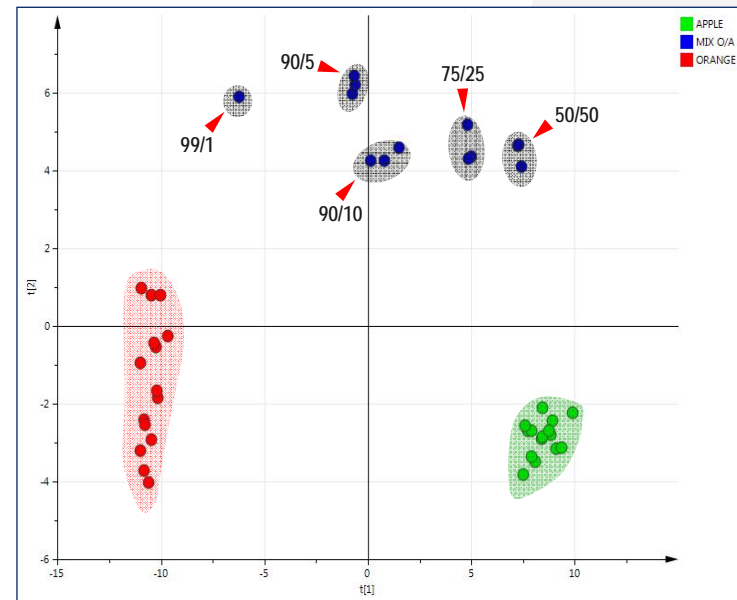
Non-Targeted Testing

EXAMPLE APPLICATION

Economically motivated adulteration of fruit juices

Dilution with water

Extension of expensive juice with cheaper juice

Partial least square – discriminant analysis model for orange juice extension with apple juice (scores plot)

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Summary

► Covance Food Solutions offer a wide range of chemical testing that helps to ensure your product is safe and regulation compliant

► Streamlined (multi-analyte) methods using mass spectrometry and hyphenated techniques are required

► Continuous innovation and search for new ways to improve quality of results, reduce turn-around times and minimize costs

► Non-targeted analysis opens door to new applications that can find unexpected contaminants and adulterants

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Thank You for Your Attention !

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www.covance.com/foodsolutions

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