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TRUST

your foods are all they should be.

Food integrity application compendium

Authenticity
Adulteration/Food fraud
Halal foods

ThermoFisher SCIENTIFIC

Table of contents

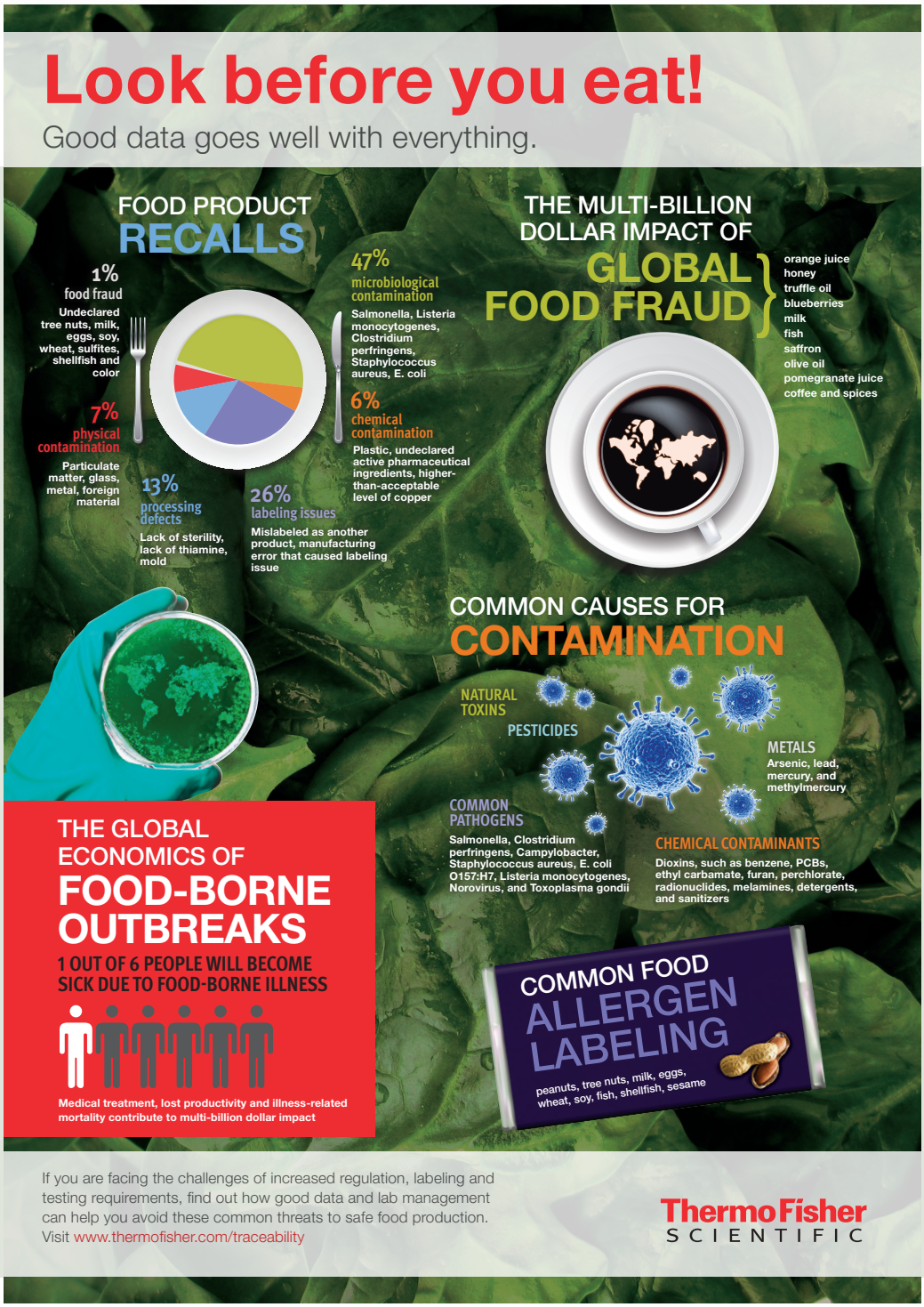
Introduction

Adulteration has become an increasing problem for the global food industry and for consumers, bringing new urgency to testing olive oil, honey, spices, meats and seafood. Determining if the product is authentic, meets label claims or has been adulterated is important for all food laboratories. The advanced instrumentation available from Thermo Fisher Scientific streamlines determination of both known and unknown components. The world's top ten food and beverage companies trust us to help keep their products safe, authentic, and unadulterated.

This food integrity compendium highlights key applications for authenticity, adulteration and halal foods.

General

Infographic



Full infographic

General

The Analytical Scientist article

Attaining accurate authentication

By Jana Hajšlová, Professor and Laboratory Head, Department of Food Chemistry and Analysis, University of Chemistry and Technology, Prague, Czech Republic.

My father graduated from the same university as me – the Institute of Chemical Technology Prague – and specialized in inorganic chemistry, so it wasn't too difficult to decide how I wanted my career to develop. But my father had set the academic bar very high; he was a guru in several weighty fields, including semiconductor research, and also worked for the United Nations on geological research projects. I decided to take a different route through chemistry and joined the faculty of food and biochemial technology. In the beginning, my father was a little disappointed by my choice as he considered it "university cooking", but it didn't take him long to realize that food chemistry and analysis was an exciting and cutting-edge field. Indeed, food analysis presents some of the most complicated matrices, which makes trace analysis very challenging at times. I too realized that I'd made an excellent choice and never regretted it.

Bitten by the technology bug

In the early days, I remember using gas chromatography instruments manufactured in Czechoslovakia; currency issues and availability prevented us from exploring imported options. The instruments were complex with many buttons and functions, but worked very well. More importantly, they allowed me to discover a great fondness for separation science – and technology. Even back then, I was doing sensory analysis on GC by removing the FID on repeat experiments and inhaling the scents from the peaks. Later, I moved more firmly into food safety because environmental issues were beginning to drive the industry towards change. I remember using a single chromatograph (funding was still challenging) connected to four selective detectors and an electronic printer; it was high technology at the time and very exciting. I knew I always wanted to be at the cutting-edge in terms of analytical instrumentation.

In the mid-1980s, I did a couple of years as visiting scientist at the Free University of Amsterdam work on very advanced techniques under two renowned chromatographers: Roland Frei and Udo Brinkman (who was head of the Royal Netherlands Chemical Society). Michel Nielen (now at RIKILT Wageningen UR) was my peer and remains my good friend and colleague. We are co-chairing the 7th International Symposium on Recent Advances in Food Analysis (RAFA 2015, www.rafa2015.eu) in November.

When I returned to the Institute in Prague, we started working on many more international collaborations and advanced instrumentation was more readily available. Our strategy was to focus on advances in mass spectrometry – something we continue to do today. We have a huge interest in assessing novel instruments and techniques from all the major companies. When I was asked to evaluate GC-Orbitrap technology ahead of its launch at ASMS 2015, I of course responded positively.

GC-Orbitrap technology – a true novelty

The pace of technological innovation has been startling, but the analytical challenges have also changed tremendously; the two aspects are part of the same cycle. Over the years, technology, such as automated sample injection and the sensitivity increase delivered by triple quadrupole MS (in both GC and LC), have constantly strived to answer the analytical questions of the moment. I was

General

The Analytical Scientist article (continued)

Attaining accurate authentication

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telling my students recently that the current challenges in food analysis are most likely to be addressed by high-resolution MS (HR-MS), which offers so many advantages compared with unit resolution MS/MS. In the past, I've worked with medium resolution time-of-flight (TOF).

In the past, I've worked with medium resolution time-of-flight (TOF) instruments with a maximum resolving power of about 10,000 FWHM, and then moved onto improved TOFs with about 30,000 FWHM. Orbitrap technology coupled to LC was a real breakthrough, offering resolution up to 60,000 FWHM with high mass accuracy – and further developments increased resolving power in some variants up to 450,000 FWHM (at *m/z* 200).

Today, Orbitrap is available for GC instrumentation in the Thermo Scientific™ Q Exactive™ GC Orbitrap™ GC-MS/MS system, which is yet another key advance. I consider myself impartial when it comes to technology, but I can say that GC-Orbitrap technology offers several real benefits. I was particularly impressed with the linearity range of the instrument, which is a limitation of TOF instruments. In 'fingerprinting' style studies, relative ratios of responses for features are also diagnostic, so linearity plays a very important role. In our studies, we saw good linearity over six or seven orders of magnitude.

For me, two challenging areas stand out as real opportunities for Orbitrap technology to differentiate itself against triple-quadrupole instrumentation. The first is non-targeted screening, where you wish to confirm whether or not a sample is contaminated with unknown compounds – mycotoxins or other natural toxins using Thermo Scientific™ LC-Orbitrap™, for example.

Here, the combination of full scan and accurate mass is unparalleled, as discussed in my recent lecture 'Effective Food Safety Control: Pesticide Residues and More within a Single Run' at the 1st International Symposium on Recent Developments in Pesticide Analysis (you can watch the video here: http://tas.txp.to/0915/janapresents). The second area is food authentication, which I believe is even more challenging. Traditionally, several markers have been used to answer questions of authentication, but with little in-depth knowledge of the matrices and other potential clues. Comprehensive MS fingerprinting using full-scan HRAM data coupled with advanced chemometrics can offer surprising insights into authenticity and classification of samples – something that was not before possible in a single analytical run.

Whiskey or Whisky?

When I tested the Q Exactive GC ahead of its launch, I was keen to benchmark it in three main areas: linearity, sensitivity and selectivity. But more than that, I wanted to assess its potential in the aforementioned area of food authenticity, which is why we focused on several whisky samples in addition to pesticide analysis. I was quite surprised to find that many compounds were identified automatically in both sets of samples, which proved to me that the deconvolution function was working well.

Analyzing the very important food commodity that is whisky seemed like a good idea given the fact I was in the UK. In particular, we were interested to see if we could authenticate whiskies in terms of age, geographical origin, brand and raw materials by building up databases and statistical models from samples of known origin. The end game is to use the data and models generated

General

The Analytical Scientist article (continued)

Attaining accurate authentication

By Jana Hajšlová, Professor and Laboratory Head, Department of Food Chemistry and Analysis, University of Chemistry and Technology, Prague, Czech Republic.

to assess unknown samples using HRAM fingerprints to gain a probability of authenticity. In our early work with GC-Orbitrap technology, we were fine tuning the method and found that ethyl acetate extraction gave us a good signature in terms of the compounds derived from the oak casks used in the aging process for whisky. As I hinted earlier, I was especially impressed with the linearity across major and minor compounds and the ability to identify ions that could be used to discriminate between whiskies.

A growing wish list of recent advances

Having spent time with GC-Orbitrap technology, what is my conclusion? Well, the Q Exactive GC is on my wish list! Especially as we have plans to establish a center of excellence in food and nutritional science – and that means we need great instrumentation. GC-Orbitrap technology represents the current pinnacle of innovation in that space right now, and would complete my collection – after all, I already have four TOF instruments, including a GC×GC-TOF-MS system.

Over the next few weeks, Michel Nielen and I – along with the rest of the team – will be conducting the strict selection process of oral abstracts for RAFA 2015. We started the conference 14 years ago to place an emphasis on excellence – and, as the name indicates, recent advances in the field – the two aspects that drive our selection process. Notably, we made a decision right from the beginning to separate presentations from independent (academic or industry) scientists and instrument company researchers – though certainly not in terms of quality. Richard Fussell is a perfect example of a quality scientist who will command attention and respect on both sides of the divide. Indeed, vendor lunchtime seminars are always packed and I am sure we will learn more about the Q Exactive GC this November. I will also be very interested to see if anyone will independently present work based on their experience with GC-Orbitrap technology – I'm quite confident we will...

When I was invited to Thermo Fisher Scientific's laboratory in Runcorn, UK, to test drive GC-Orbitrap technology, I was very curious to learn what added value or extra features it could offer. I can say that it certainly fills a gap – especially in metabolomic style approaches. I also suspect it will have a disruptive impact on certain areas of the mass spectrometry market. My independent advice? Take Orbitrap technology for a spin and decide for yourself.

Video interview with Jana Hajšlová:
tas.txp.to/0915/Jana
To find out more:
thermoscientific.com/QExactiveGC

Read the full article.

General

Application summary AN 1064

Product authentication and adulteration determination using a novel spectro-electro array platform

Paul A. Ullucci, Marc Plante, Ian N. Acworth, Christopher Crafts, and Bruce Bailey
Thermo Fisher Scientific, Chelmsford, MA, USA

Overview

Plants contain an extraordinarily diverse variety of secondary metabolites, including polyphenols, alkaloids, and terpenoids, with potential roles in the purported health benefits as well as the quality and sensory characteristics of plant-based beverages such as juice, wine, beer, and tea.

This application note presents a method using chemometric modeling software to evaluate changes in metabolite patterns that can indicate product adulteration, contamination, composition, and stability, and—in the case of wine and juice—the effects of growing region and differences between the varietals used in production.

Method

A gradient HPLC method was established using spectro-electro array detection to easily generate both targeted and information-rich metabolomic data. Metabolite profiles are generated with sensitive three-dimensional EC array data, which can be imported into pattern-recognition software and combined with principal component analysis (PCA) to readily identify product adulteration and authenticity.

Part Number	Description
063691	Thermo Scientific™ Acclaim™ 120 column, C18, 3 µm analytical (3.0 × 150 mm)

Conclusion

Using this method, PCA easily differentiated a variety of wines and teas. Fruit juice adulteration was readily detected, and it was possible to classify orange juice samples by varietal and geographical region. Although this work highlighted the application of the method to beverages, this method is also applicable to other fields, including botanical/supplement testing, fuel/oil testing, drug testing, and counterfeit product identification.

Thermo Scientific™ UltiMate™ 3000 Rapid Separation system

Read the full application note.

Dyes

Application summary AN 245

Fast HPLC analysis of dyes in foods and beverages

Overview

In the food and beverage industries, dyes may be used to make food more appealing, hide defects, or to strengthen consumer perception of the association between color and flavor. While many dyes exist, only a few have been approved for use in foods and beverages.

Method

This application note demonstrates fast separation of 10 dyes in less than 5 minutes using a Thermo Scientific™ Acclaim™ PA2 column, which is suited to resolving mixtures of compounds with a wide range of hydrophobicities, including very polar compounds.

Part Number	Description
066277	Acclaim PA2 (3 µm) column in a 3 × 75 mm format

Conclusion

This method was used to determine the quantity of food dyes in six soft drinks and a gelatin dessert. It is suitable for the fast (< 5 minutes) analysis of food and beverage samples that have both approved and illegal dyes.

Thermo Scientific™ UltiMate™ 3000 Rapid Separation system

Read the full application note.

Fish



Poster summary PN 64845

From ocean to table: an integrated mass spectrometry approach to identify the fish on your plate

Chien Hsun Chen,[1] Andreas Krupke,[1] Monica Carrera,[2]
Aran Paulus, Andreas FR Huhmer,[1] and Daniel Lopez-Ferrer[1]
[1]Thermo Fisher Scientific, Chelmsford, MA, USA; [2]Marine Research Institute, Vigo, Spain

Overview

As worldwide demand for fish continues to expand, depletion of desirable fish species and fraud in the marketplace represent growing problems. This poster note presents an integrated proteomics approach to authenticate fish species of commercial interest from a muscle tissue sample.

Method

This method determines a species-characteristic protein mass fingerprint using electrospray ionization mass spectrometry (ESI-MS/MS).

Prepared and desalted samples were separated and analyzed on a Thermo Scientific™ EASY-nLC™ 1200 system hyphenated to a Thermo Scientific™ Q Exactive™ Hybrid Quadrupole-Orbitrap™ mass spectrometer. Data were submitted for database search using Thermo Scientific™ Proteome Discoverer™ software and a composite protein database of known fish species.

Part Number	Description
89879	Thermo Scientific™ Pierce™ Micro-Spin columns for desalting
ES800	Thermo Scientific™ EASY-Spray™ column (15 cm)

Conclusion

This method successfully identified the species of an unlabeled commercial hake filet. Intact MS analysis of thermostable proteins represents a promising approach for rapid and effective seafood identification and authentication.

Q Exactive Hybrid Quadrupole-Orbitrap Mass Spectrometer system

Read the full poster note.

Fruit

Application summary AN 281

Rapid and sensitive determination of anthocyanins in bilberries using UHPLC

Overview

Bilberry extracts are widely used in nutritional supplements and pharmaceuticals for improving visual acuity and treating circulatory disorders. Bilberries cannot be cultivated and are difficult to harvest and process, making them one of the most expensive botanical ingredients in the health food industry. Chemical and pharmacological studies have identified anthocyanins as the main components responsible for their therapeutic effect.

This application note presents a rapid, simple, and reproducible method to determine anthocyanins in bilberry-based nutraceutical products to ensure their potency.

Method

This method uses HPLC with a high-resolution silica-based C18 column and photodiode array detection to separate, detect, and quantify anthocyanins in several commercially available bilberry nutritional supplements.

Part Number	Description
059130	Thermo Scientific™ Acclaim™ RSLC 120 C18, 2.2 µm, analytical column, 2.1 × 150 mm

Conclusion

This method accurately separated and quantified anthocyanins in commercially available nutraceutical products with minimal sample preparation and in only 30 minutes, compared to competing methods with run times of 50 minutes or greater.

Thermo Scientific™ UltiMate™ 3000 Rapid Separation system

Read the full application note.

Vegetables

Application summary AB 30399

EA-IRMS: Detecting organic grown vegetables

Christopher Brodie and Oliver Kracht, Thermo Fisher Scientific, Bremen, Germany

Overview

As organic fruit and vegetables attract a higher price on the market, this can lead to economically motivated fraud through mislabeling produce as “organic” when they have been grown using synthetic fertilizer. The identification of mislabeled fruit and vegetables represents a challenge as laboratories need a technique that identifies fruits and vegetables grown using organic fertilizers and synthetic fertilizers with full confidence in results. The identification of mislabeled products subsequently protects consumer confidence, brand market reputation related revenue-generating capabilities.

Method

The nitrogen isotope fingerprints of vegetables are used to differentiate whether the fertilizer used for plant growth was organic or synthetic. Vegetables grown using organic fertilizers, such as peat, sewage sludge and animal manure, tend to have nitrogen isotope values between +8‰ to +20‰.

Part Number	Description
0723640	Thermo Scientific™ Flash IRMS Elemental Analyzer
0723654	Thermo Scientific™ DELTA™ V Advantage IRMS
1222750	Thermo Scientific™ Conflo IV Universal Interface

Vegetables grown using synthetic fertilizers, such as potash and ammonia, tend to have nitrogen isotope values of +3‰ to +6‰. This differentiation provides a framework to detect vegetables grown using organic or synthetic fertilizers thanks to a strong ^{15}N isotope resulting from ammonia volatilization, denitrification, nitrification and other N transformation processes prior to plant uptake.

Conclusion

The tomatoes grown using organic fertilizer can be differentiated from tomatoes grown using synthetic fertilizer using nitrogen isotope fingerprints. This illustrates the potential of a simple tool for verifying label claims associated with organic fruit and vegetables.

Thermo Scientific™ EA IsoLink™ IRMS system

Read the full article here.

Meat

Application summary AB 30572

EA-IRMS: Isotope fingerprints reveal the origin of beef based on diet

Christopher Brodie, Thermo Fisher Scientific, Bremen, Germany

Overview

The introduction of pan-European compulsory beef labelling rules, from the 1st September 2000 onwards was designed to provide consumers with correct, complete and transparent information to enable them to make an informed choice on the type and origin of beef they purchased (Council Regulation (EC) No. 2772/1999). As a consequence of this legislation it is reasonable to suggest that there should be analytical methods in place that can verify the information provided on origin labels describing where an animal has been reared.

Method

The origin of beef can be tracked using the carbon isotope fingerprint which is related to the photosynthetic signature of the plants consumed by the animals during their grazing. To identify beef of UK origin relative to beef of Brazilian origin, this can be readily differentiated using carbon isotope fingerprints. The carbon isotope fingerprint ($\delta^{13}C$) of plants are different because of photosynthetic processes and broadly grouped as C_3, C_4 and CAM plant types. C_3 plants have a carbon isotope fingerprint between -33‰ to -22‰, C_4 plants a carbon isotope fingerprint between-16‰ to -8‰, and CAM plants between -20‰ to -10‰. Cattle in the UK and northern Europe are reared on pastures with C_3 plant types whilst in Brazil and USA they are reared on pastures with C_4 plant types.

Part Number	Description
0723640	Thermo Scientific™ Flash IRMS Elemental Analyzer
0723654	Thermo Scientific™ DELTA™ V Advantage IRMS
1222750	Thermo Scientific™ Conflo IV Universal Interface

Conclusion

As a result, the animal meat carries the dietary carbon isotope fingerprint. The nitrogen isotope fingerprint can further differentiate by tracking differences in plant fertilization and also pastures with leguminous plants. The Figure clearly shows the differentiation, for example, between beef sourced in the UK and North and South America.

Thermo Scientific™ EA IsoLink™ IRMS system

Read the full article here.

Meat

Application summary AN 65438

Meat authentication and adulteration testing by HPLC combined with high-resolution, accurate-mass (HRAM) mass spectrometry

Overview

Meat authenticity in food testing laboratories has been traditionally performed using polymerase chain reaction (PCR) and enzyme-linked immunosorbent assay (ELISA). These methods require intensive customization to achieve the required sensitivity and accuracy. In addition, the molecular information obtained is incomplete and data mining cannot be performed post-analysis.

This application brief presents a bottom-up proteomic strategy applied to meat speciation using targeted tryptic peptide biomarkers with HPLC and High-resolution mass spectrometry technology.

Method

This method was performed using a Thermo Scientific™ UltiMate™ 3000 Rapid Separation UHPLC coupled to a benchtop Thermo Scientific™ Q Exactive™ Hybrid Quadrupole-Orbitrap™ Mass Spectrometer.

Conclusion

This application shows that myoglobin proteotypic peptides can be used to preform meat speciation. Moreover, thorough in silico protein sequence analysis and tryptic digestion allowed the identification of three other proteotypic peptide biomarkers.

Part Number	Description
72205-101030	Thermo Scientific™ BioBasic™ C8 column (5 µm, 100 × 1 mm)

PRM methods can be fully validated for meat authentication and adulteration analysis. For research, DIA provides a more detailed data set and allows comprehensive data mining.

Q Exactive Hybrid Quadrupole-Orbitrap Mass Spectrometer system

Read the full application note.

Halal foods

Application summary AN 646

Determination of meat authenticity using a comprehensive targeted proteomic strategy and high-resolution mass spectrometry

Overview

Due to the internationalization of food production and distribution, there has been a significant increase of food fraud in recent years. For example, in 2013, horse and pig DNAs were detected in beef products sold by several retailers.

This application brief presents a sensitive and robust liquid chromatography/mass spectrometry (HRAM LC-MS) method for the identification and detection of marker proteins in raw meat samples.

Method

This method was performed using a Thermo Scientific™ UltiMate™ 3000 RSLC system coupled to a benchtop Thermo Scientific™ Q Exactive™ Hybrid Quadrupole-Orbitrap™ Mass Spectrometer.

Part Number	Description
72205-101030	Thermo Scientific™ BioBasic™ C8 column (5 µm, 100 × 1 mm)

Conclusion

This targeted method enabled the detection of undesired meat species down to 1% (w/w) of the entire sample with a potential to go significantly lower using straightforward sample enrichment techniques.

Q Exactive Hybrid Quadrupole-Orbitrap Mass Spectrometer system

Read the full application note.

Honey

Application summary AN 1158

HPAE-PAD determination of carbohydrates in honey to evaluate samples for quality and adulteration

Manali Aggrawal and Jeffrey Rohrer, Sunnyvale, CA, USA

Overview

The sugar composition of honey is mainly dependent on its floral source. It is also affected by climate, processing, and storage conditions. Studies have shown that the amount of sucrose can be used to differentiate the adulteration of honey samples by sugar syrups. Therefore, carbohydrate analysis is important as a honey quality parameter and for floral origin determinations.

This application note presents a fast, high-resolution method to assay fructose and glucose, and to measure the entire profile of di- and trisaccharides in honey using high-performance anion exchange chromatography coupled with pulsed amperometric detection (HPAE-PAD).

Method

Sugars in 12 honey samples were determined using HPAE-PAD on a Thermo Scientific™ Dionex™ ICS-5000+ Capillary HPIC™ system. The separation uses a Thermo Scientific™ Dionex™ CarboPac™ PA210-4µm column, which was developed to provide fast, high-resolution separations for most mono- through tetrasaccharides in food and beverage samples.

Part Number	Description
088953	Dionex CarboPac PA210-4µm 4 × 150 mm analytical column
088955	Dionex CarboPac PA210-4µm 4 × 30 mm guard column
075778	Thermo Scientific™ Dionex™ EGC 500 KOH Eluent Generator cartridge

Conclusion

This HPAE-PAD method successfully performs the sugar analysis of 12 commercial honey samples. In addition, HPAE-PAD profiling provides a robust method to study the adulteration of honey samples with commercial sugar syrups. Use of the Dionex CarboPac PA210-4µm column enables the separation of 15 sugars in honey with minimal sample preparation and an overall cycle time of 45 minutes.

Dionex ICS-5000+ Capillary HPIC system

Read the full application note.

Honey

Application summary AN 30177

EA-IRMS: detection of honey adulteration

Oliver Kracht and Andreas Hilkert, Thermo Fisher Scientific, Bremen, Germany

Overview

Honey is subject to fraud by adulteration with low price invert sugar syrups. Saccharides in syrups derived from cane, corn or beet sugar are difficult to distinguish from those in pure honeys.

This application note demonstrates stable isotope analysis of honey as a means to detect adulteration, using an elemental analyzer (EA) coupled to an isotope ratio mass spectrometer (IRMS).

Method

Determination of $^{13}C/^{12}C$ isotope ratio was undertaken on a Thermo Scientific™ EA IsoLink™ IRMS system.

Conclusion

Carbon isotope fingerprints can be used to identify adulteration of honey that results form the addition of exogenous sugars.

The carbon isotope fingerprint ($\delta^{13}C$) of plants are different because of photosynthetic processes and broadly grouped as C_3, C_4 and CAM plant types. C_3 plants utilize the Calvin photosynthetic pathway to fix CO_2. C_4 plants utilize the Hatch-Slack photosynthetic pathway and CAM by Crassulacean Acid Metabolism. Therefore, C_3 plants have a carbon isotope fingerprint between -33‰ to -22‰, C_4 plants a carbon isotope fingerprint between-16‰ to -8‰. And CAM plants between -20‰ to -10‰.

EA IsoLink IRMS System

Read the full application note.

Part Number	Description
BRE723644	Thermo Scientific™ Flash IRMS Elemental Analyzer
0723654	Thermo Scientific™ DELTA™ V Advantage IRMS
1222750	Thermo Scientific™ Conflo IV Universal Interface

Honey

Application summary AN 270

Determination of hydroxymethylfurfural in honey and biomass

Lipika Basumallick and Jeff Rohrer, Thermo Fisher Scientific, Sunnyvale, CA, USA

Overview

Hydroxymethylfurfural (HMF) is a water-soluble heterocyclic organic compound derived from sugars. Naturally found in very low concentrations in fresh sugar-containing foods, HMF is also formed during extended food storage under certain conditions, and can serve as an indicator of excessive heat-treatment, spoilage, and of possible adulteration with other sugars or syrups.

This application note describes a method using high-performance anion-exchange chromatography with pulsed amperometric detection (HPAE-PAD) for the accurate determination of HMF in foods and biomass.

Method

This method is performed on a Thermo Scientific™ Dionex™ ICS-5000⁺ Capillary HPIC™ system with a Thermo Scientific™ Dionex™ CarboPac™ PA1 column, electrolytically generated hydroxide eluent, and electrochemical detection with disposable Au-on-polytetra-fluoroethylene (PTFE) working electrodes.

Part Number	Description
035391	Dionex CarboPac PA1, analytical column, 4 × 250 mm
043096	Dionex CarboPac PA1, guard column, 4 × 50 mm
058900	Thermo Scientific™ Dionex™ EGC II KOH cartridge

Conclusion

The method is shown to have a broad linear range, high precisions, and low detection limits. It is accurate and reliable, and should be applicable to online monitoring of HMF levels in food and biomass applications.

Dionex ICS-5000⁺ Capillary HPIC system

Read the full application note.

Honey

Application summary AN 30024

LC-IRMS: Compound specific isotope analysis of honey

Andreas W. Hilkert, Michael Krummen, and Dieter Juchelka, Thermo Fisher Scientific, Bremen, Germany

Overview

Sugars can carry information of the origin and processing of food products containing them. If isotopically labeled they tell us about their pathways and metabolism.

This application develops a method to determine $^{13}C/^{12}C$ isotope ratios of carbohydrates for the authentication of honey using liquid chromatography coupled with isotope ratio mass spectrometry (LC-IRMS).

Method

LC-IRMS methodology is based on the chromatographic separation of the carbohydrates and carbohydrate fractions and the subsequent determination of ^{13}C isotopic value of every individual sugar in honey.
The comparison of the $\delta^{13}C$ of fructose and glucose, the detection of other unusual sugars as well as the determination of the sugar pattern can be determined within a single HPLC run.

Conclusion

Using this method, small amounts in complex mixtures can be analyzed for compound-specific isotope analysis without extensive preparation or derivatization. This multi-parametric methodology approach demonstrates how different cases of adulterated honey can be detected by combining compound specific and bulk analysis.

LC IsoLink IRMS System

Read the full application note.

Part Number	Description
0723654	Thermo Scientific DELTA V Advantage IRMS
0722773	Thermo Scientific LC Isolink Interface
(variable)	Thermo Scientific UltiMate 3000 HPLC

Honey

Application summary CAN 123

Sugars in honey using HPAE-PAD: What is the best column?

Katrin Hostettler,[1] Robert Brogioli,[1] Silvio Arpagaus,[1] Beate Müller-Werner,[2] Detlef Jensen[2]
[1]Department of Food Control and Consumer Protection, Lucerne, Switzerland
[2]Thermo Fisher Scientific, Switzerland

Overview

The sugar content in honey varies depending on region of production, flower, and feeding practice of the bees. For this reason, the quantification of a broad variety of sugars in honey samples is a useful tool for verifying product declaration and labeling as well as uncovering honey adulteration.

This customer application note compares the performance of three columns for the determination of sugars in different honey samples using high-performance anion-exchange chromatography with pulsed amperometry detection (HPAE-PAD).

Method

This study compares the following column sets using HPAE-PAD.

Part Number	Description
062896	Dionex CarboPac PA200 column, 3 × 250 mm
062895	Dionex CarboPac PA200 guard, 3 × 50 mm
057180	Dionex CarboPac PA10 column, 2 × 250 mm
057181	Dionex CarboPac PA10 guard, 2 × 50 mm
057182	Dionex CarboPac PA100 column, 2 × 250 mm
057183	Dionex CarboPac PA100 guard, 2 × 50 mm

Conclusion

The Thermo Scientific™ Dionex™ CarboPac™ PA100 analytical & guard column allows the separation of fructose, glucose, sucrose, turanose, maltose, trehalose, isomaltose, erlose, raffinose, and melezitose with minimum sample preparation and an overall cycle time of 38 minutes. The detection method is sensitive enough to allow the determination of lower concentrations of carbohydrates, while also being robust enough to handle higher concentrations of the major components glucose and fructose.

Thermo Scientific™ Dionex™ ICS-5000⁺ Reagent-Free HPIC system

Read the full application note.

Edible oils

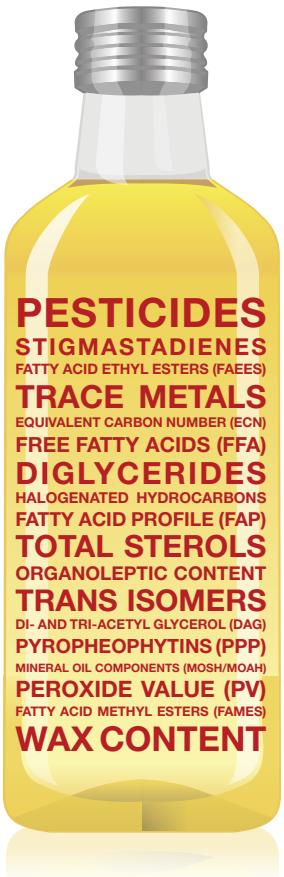
Infographic

thermoscientific

Olive oil should ONLY be olive oil.

The olive oil industry faces increased pressure to prove that its products live up to the quality and origin on the bottle. Consumers are now more aware than ever, that olive oils may not always be what is claimed or advertised. Our separation and detection technologies provide ideal solutions to address these challenges the olive oil industry faces today.

WHAT'S POTENTIALLY IN MY BOTTLE?



KEY AREAS IN OLIVE OIL TESTING

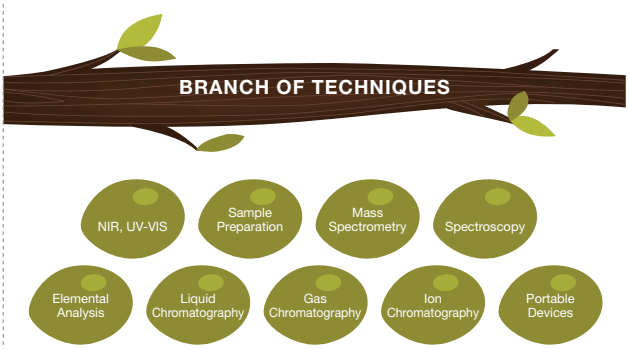
NUTRITION FACTS

Nutritional value per 100 g (3.5 oz)		
Energy	3,699 kJ (884 kcal)	
Carbohydrates	0 g	
Fat	100 g	
Saturated	14 g	
Monounsaturated	73 g	
Polyunsaturated	11 g	
omega-3	0.8 g	
omega-6	9.8 g	
Protein	0 g	
Vitamins		
Vitamin E	14 mg	(93%)
Vitamin K	60 µg	(57%)
Minerals		
Iron	0.56 mg	(4%)

Units
µg = micrograms • mg = milligrams
IU = International units

Percentages are roughly approximated using US recommendations for adults.
Source: USDA Nutrient Database

BRANCH OF TECHNIQUES



YOUR BRAND IS EVERYTHING.

ThermoFisher.com/EdibleOilTesting

ST72120-EN 0716M

ThermoFisher SCIENTIFIC

[Full infographic]

Edible oils

Application summary AB 30276

EA-IRMS: Detection of squalane from animal and vegetable sources

Overview

Squalane and its natural precursor squalene are widely used in cosmetic products such as skin moisturizers. Many consumers now prefer renewably sourced, animal-free cosmetics. The two major source materials for squalene are shark liver oil and olive oil, which exhibit significantly distinct carbon isotopic compositions, and thus, can provide a means to identify the source material.

This application note presents a method for distinguishing origins of squalane using an elemental analyzer coupled to an isotope ratio mass spectrometer (EA-IRMS).

Method

Carbon isotope compositions of squalene and squalane from shark liver oil, olive oil, and mixtures of both oils were measured by the Thermo Scientific™ EA IsoLink™ IRMS system.

Part Number	Description
BRE723644	Thermo Scientific™ Flash IRMS Elemental Analyzer
0723654	Thermo Scientific™ DELTA™ V Advantage IRMS
1222750	Thermo Scientific™ Conflo IV Universal Interface

Conclusion

This method determined a significant difference in $\delta^{13}C$ between the two sources of squalane. The high precision of EA-IRMS facilitates reliable and conclusive quantifications of the contents of squalane derived from olive oil versus shark liver oil in mixtures.

Thermo Scientific™ EA IsoLink™ IRMS system

Read the full application brief.

Spices

Application summary AN 20853

Separation of curcuminoids from turmeric—comparison of polar embedded and C18 solid HPLC core columns

Overview

Turmeric is a popular spice, coloring agent, and ingredient in traditional Ayurvedic medicine. Its chief bioactive components are the brilliant yellow pigments curcumin, desmethoxycurcumin, and bis-desmethoxycurcumin, along with other minor curcuminoids.

This application note compares a competitor's solid-core C18 column against the Thermo Scientific™ Accucore™ Polar Premium column to demonstrate the use of alternate selectivity to solve separation challenges in determining curcuminoids.

Method

This method was performed using a Thermo Scientific™ Dionex™ UltiMate™ 3000 RS HPLC system with a DAD-3000RS diode-array detector.

Part Number	Description
28026-103030	Accucore Polar Premium column, 2.6 µm, 100 × 3.0 m

Conclusion

The Accucore Polar Premium column's chemistry provides a selectivity that resolves the major and minor components of curcumin under simple isocratic conditions in about three minutes, while C18 columns fail to separate these components.

UltiMate 3000 Rapid Separation system

Read the full application note.

Spices

Application summary AN 287

Two-dimensional HPLC combined with on-line SPE for determination of sudan dyes I–IV in chili oil

Overview

Sudan dyes belong to a family of industrial dyes normally used for coloring plastics and other synthetic materials. Although use of these dyes in food is restricted due to adverse health effects, they are nevertheless sometimes added to foods to improve the appearance and command a higher price.

In this application note, a two-dimensional HPLC with on-line solid-phase extraction (SPE) method was developed for fast, effective determination of Sudan dyes I–IV in chili oil without the need for time-consuming manual sample preparation.

Method

This method uses automated, in-line SPE and two-dimensional HPLC separation on a Thermo Scientific™ Dionex™ UltiMate™ 3000 HPLC dual-pump system equipped with an on-line SPE intercolumn trapping system, controlled by Thermo Scientific™ Dionex™ Chromeleon™ Chromatography Data System software.

Part Number	Description
063705	Thermo Scientific™ Acclaim™ Polar Advantage II (PA2), 3 µm, 3.0 × 150 mm
068982	Thermo Scientific™ Acclaim™ RSLC 120 C18 column, 2.2 µm, 2.1 × 100 mm

Conclusion

This method uses the separation power of the first column to efficiently eliminate interferences, and uses the second column to separate the analytes, eliminating the need for off-line sample preparation.

UltiMate 3000 Rapid Separation system

Read the full application note.

Spices

Application summary AB 163

Determination of capsaicinoids in chili pepper using HPLC-ECD

Bruce Bailey and Ian Acworth, Thermo Fisher Scientific, Chelmsford, MA, USA

Overview

Capsaicin is a major lipophilic alkaloid of Capsicum fruits such as chili pepper and paprika. Capsaicin is used as a food additive in spicy cuisines, and also as a treatment for certain types of pain and inflammation. The hotness of a pepper depends upon its content of capsaicin and related capsaicinoids.

This application brief presents a fast and sensitive HPLC-electrochemical detection (ECD) method for determining capsaicinoids.

In this application note, a two-dimensional HPLC with on-line solid-phase extraction (SPE) method was developed for fast, effective determination of Sudan dyes I–IV in chili oil without the need for time-consuming manual sample preparation.

Method

The isocratic analytical system used consisted of a pump, autosampler, thermostatic chamber, a four channel Thermo Scientific™ Dionex™ CoulArray™ Coulometric Array detector and an UV/vis detector placed before the array. In a separate profiling study, the pattern of chili pepper metabolites was measured using gradient HPLC coupled to an array of sixteen coulometric sensors.

Part Number	Description
063691	Thermo Scientific™ Dionex™ C18, 3 × 150 mm, 3 µm column

Conclusion

This study presents a routine, stable, selective and highly sensitive HPLC-coulometric electrochemical array assay capable of accurately measuring capsaicin and its related metabolites. In addition, the profiling study reveals the pattern of metabolites, which can be used to measure product shelf life, adulteration and material source, contamination, formulation of blends and more.

Thermo Scientific™ UltiMate™ 3000 Rapid Separation system

Read the full application brief.

Spices

Application summary AB 168

Deconvolution of curry powder constituents using HPLC-ECD

Paul Gamache and Ian Acworth, Thermo Fisher Scientific, Chelmsford, MA, USA

Overview

Understanding the dynamics of a mixture of complex materials such as curry powders poses difficult analytical problems.

This application brief develops develop a robust and sensitive HPLC-electrochemical detection (ECD) method for separating and analyzing non-volatile phenols, flavonoids and related compounds in curry powder.

Method

This study uses HPLC coupled with coulometric array detection to produce sensitive and selective data, creating three-dimensional chromatograms, or analyte patterns, for each sample. The method uses a gradient analytical system consisted of two pumps, an autosampler, a 16-channel Thermo Scientific™ Dionex™ UltiMate™ 3000 CoulArray™ Coulometric Array detector and software to deconvolute the samples.

Part Number	Description
059148	Thermo Scientific™ Dionex™ C18, 4.6 × 150 mm, 5 µm column

Conclusion

3D data sets describing the sample and its components are generated in real time. The data can then be analyzed in a number of ways to gain information about ingredient inter-relationships, degradation or contamination, or consistency in the ratios of starting materials. Patterns of components in the mixture can be further analyzed using external pattern recognition software.

Thermo Scientific™ UltiMate™ 3000 Rapid Separation system

Read the full application brief.

Coffee beans

Application summary AB 30427

EA-IRMS: Tracing the geographical origin of green coffee beans using isotope fingerprints

Christopher Brodie, Maryam Weigt, Oliver Kracht Thermo Fisher Scientific, Bremen, Germany

Overview

Coffee is one the most popular beverages worldwide. Coffee from different geographical regions are imported through a commercial chain that usually involves several intermediates, presenting opportunity for economically motivated fraudulent activity. To ensure that coffee beans come from their labelled locations, laboratories need an analytical tool for geographical origin discrimination with a special emphasis on the country of origin. Green coffee beans have a fingerprint, a unique chemical signature that allows them to be identified: isotope fingerprints have been reliably used for origin, authenticity and product label claim verification.

Method

The hydrogen and oxygen isotope fingerprints in coffee beans can be used to differentiate their geographical origin. The Coffea plants, from which coffee beans are cultivated, carry a local-regional fingerprint primarily associated with local and regional rainfall, but can also be influenced by cultivation practices, soil processes and geological characteristics of the local area, altitude and proximity to the shoreline.

Part Number	Description
BRE723644	Thermo Scientific™ Flash IRMS Elemental Analyzer
0723654	Thermo Scientific™ DELTA™ V Advantage IRMS
1222750	Thermo Scientific™ Conflo IV Universal Interface

This effect can be tracked in the oxygen and hydrogen isotopic fingerprints of plants and their fruits (e.g. green coffee beans). With hydrogen and oxygen isotope fingerprints, coffee beans can be clearly differentiated at the continent scale. Additionally, the Bio Sumatra coffee measured is grouped with coffee from South and Central America rather than from Asia (red marker), illustrating that mislabeling can be identified.

Thermo Scientific™ EA IsoLink™ IRMS system

Read the full article here.

Sugar

Application summary AB 30424

EA-IRMS: Testing sugar package label claims using carbon isotope fingerprints

Maryam Weigt, Christopher Brodie, Oliver Kracht, Thermo Fisher Scientific, Bremen, Germany

Overview

Sugar is primarily refined from Saccharum spp. (sugar cane), which grows above the ground under tropical climates, and Beta vulgaris (sugar beet), which grows underground under temperate climates. The refining process for beet is simpler and faster than for cane. Furthermore, beet can grow in a variety of climates beyond tropical regions and thus can be sourced locally. Consequently, beet sugar is cheaper to manufacture and source. This economic consideration may lead to fraud with the mislabeling of beet sugar. Testing the accuracy of product label claims is one of the key ways of monitoring and enforcing legislation on food product labelling (EC Reg. No. 1169/2011 and FDA-2012-N-1210).

Method

Sugar has a fingerprint, a unique chemical signature that allows it to be identified. The carbon isotope fingerprint ($\delta^{13}C$) of plants are different because of photosynthetic processes and broadly grouped as C_3 and C_4 plant types. Beta vulgaris, cultivated as the source of beet sugar, is a C_3 plant, whereas Saccharum spp., cultivated as source of cane sugar, is a C_4 plant. C_3 plants have carbon isotope fingerprint between -33‰ to -22‰ and C_4 plants have a carbon isotope fingerprint between -16‰ to -8‰, allowing differentiation of sugar sources.

In this study, 28 sugar packages from 25 countries were analyzed to verify the accuracy of package label claims using carbon isotope fingerprints.

Part Number	Description
0723640	Thermo Scientific™ Flash IRMS Elemental Analyzer
0723654	Thermo Scientific™ DELTA™ V Advantage IRMS
1222750	Thermo Scientific™ Conflo IV Universal Interface

Conclusion

Although some of the sugars analyzed did not have a label claim, the differences in their carbon isotope fingerprints enabled us to distinguish between cane sugar and beet sugar.

Thermo Scientific™ EA IsoLink™ IRMS system

Read the full article here.

Beverages

Application summary AN 1065

Gradient HPLC method for analysis of beer polyphenols, proanthocyanidins, and bitter acids using a novel spectro-electro array platform

Paul A. Ullucci, Ian N. Acworth, Marc Plante, Bruce A. Bailey, and Christopher Crafts
Thermo Fisher Scientific, Chelmsford, MA, US

Overview

Beer contains a complex mixture of phenolic compounds, bitter acids, and polyphenols extracted from the starch source and hops. These elements contribute to the flavor, including bitterness, as well as stability, and in some cases, degradation of the beverage.

This application note develops gradient high-performance liquid chromatography (HPLC) methods using a spectro-electro array platform to measure specific analytes in beer samples and—in a metabolomic approach—to distinguish between different beer samples and study beer stability.

Method

This study uses a Thermo Scientific™ Dionex™ UltiMate™ 3000 HPLC system equipped with a Thermo Scientific™ Dionex™ UltiMate™ 3000 Rapid Separation Diode Array Detector, Thermo Scientific™ Dionex™ UltiMate™ 3000 CoulArray™ Coulometric Array detector, and Model 5011A High Sensitivity Analytical Cell.

Part Number	Description
063691	Thermo Scientific™ Acclaim™ 120 C18, 3 µm analytical column (3.0 × 150 mm)

Conclusion

Three methods are developed: one for determination of polyphenols, a second for determination of bitter acids, and a metabolomics approach. Method 1 can be used in a targeted approach to accurately and sensitively measure numerous phenols, phenolic acids, and polyphenols in beer and other samples. Method 2 enables sensitive, targeted measurement of multiple bitter acids in a single run. Metabolomic approaches can be used to differentiate between different beers.

UltiMate 3000 Rapid Separation system

Read the full application note.

Beverages

Application summary AB 201

Determination of carbohydrates in coffee using a compact ion chromatography system

Sachin Patil and Jeff Rohrer, Thermo Fisher Scientific, Sunnyvale, CA, USA

Overview

Carbohydrates constitute as much as 50% of raw coffee beans, and contribute to the flavor, viscosity, and aromas of the beverage. They are also useful tracers for assessing the authenticity of soluble (instant) coffee.

This application proof note demonstrates a fast, high-resolution method for determining common sugars of interest in foods and beverages using high-performance anion-exchange (HPAE) chromatography with pulsed amperometric detection (PAD).

Method

This study uses HPAE-PAD on a Thermo Scientific™ Dionex™ Integrion™ HPIC™ system. The Thermo Scientific™ Dionex™ CarboPac™ SA10 column used in the related Thermo Scientific™ Application Note 280 (AN280) is replaced with the Dionex CarboPac SA10-4µm column which delivers faster and greater resolution separations.

Part Number	Description
088233 (standard) 088235 (microbore)	Dionex CarboPac SA10-4µm analytical column
088234 (standard) 088236 (microbore)	Dionex CarboPac SA10-4µm guard column

Conclusion

This study examines the effect of brewing heat and time on sugar content of coffee samples.

Dionex Integrion HPIC system

Read the full application note.

Beverages

Application summary AN 280

Carbohydrate in coffee: AOAC method 995.13 vs a new fast ion chromatography method

Lipika Basumallick and Jeff Rohrer, Thermo Fisher Scientific, Sunnyvale, CA, USA

Overview

Carbohydrates constitute the major part of raw coffee beans. The carbohydrates in coffee contribute to the flavor of the beverage, as they undergo complex changes during the roasting process. They act as aroma binders, foam stabilizers, and also impart viscosity. They are also useful tracers for assessing the authenticity of soluble (instant) coffee.

This study compares two methods using high-performance anion-exchange (HPAE) chromatography with pulsed amperometric detection (PAD) for the determination of carbohydrates in extracts from instant coffee and green coffee beans: the Association of Analytical Chemists (AOAC) official method 995.13, and a fast method using the Thermo Scientific™ Dionex™ CarboPac™ SA10 analytical and guard columns.

Part Number	Description
035391	Thermo Scientific™ Dionex™ CarboPac™ PA1 analytical column (4 × 250 mm)
43096	Dionex CarboPac PA1 guard column (4 × 50 mm)
074641	Dionex CarboPac SA10 analytical column (4 × 250 mm)
074902	Dionex CarboPac SA10 guard column (4 × 50 mm)

Method

Both methods were performed using HPAE-PAD on a Thermo Scientific™ Dionex™ ICS-5000 or ICS-3000 Ion Chromatography system with electrolytic eluent generation.

Conclusion

The AOAC method has a longer run time (80 minutes) compared to the fast method (10 minutes). For certain sugars that might be difficult to resolve with the official method, minor modifications are suggested. The fast method resolves 7 of the 11 coffee carbohydrates in 8 minutes and needs only the addition of deionized (DI) water for continuous operation.

Dionex ICS-5000⁺ Capillary HPIC system

Read the full application note.

Beverages

Application summary AU 202

A fast method for sugar analysis of instant coffee samples

Sachin Patil and Jeffrey Rohrer, Thermo Fisher Scientific, Sunnyvale, CA

Overview

Carbohydrates are an important constituent of the coffee beans. They undergo complex changes during roasting and can affect the final taste and aroma of the coffee. Carbohydrate content is also used for detecting coffee adulteration.

The current study updates a fast method for determining carbohydrates in coffee described in Thermo Scientific™ Application Note 280 (AN280) to use the Thermo Scientific™ Dionex™ CarboPac™ SA10-4µm column.

Method

This method quickly determines sugars in instant coffee using a Thermo Scientific™ Dionex™ Integrion™ HPIC™ system with electrolytically generated eluent and electrochemical detection.

Part Number	Description
088233	Dionex CarboPac SA10-4µm column
088234	Dionex CarboPac SA10-4µm guard column 4 × 50
075778	Thermo Scientific™ Dionex™ EGC 500 KOH Eluent Generator cartridge
088662	Thermo Scientific™ Dionex™ ATC-600 Continuously Regenerated Anion Trap column

Conclusion

The smaller particle size of the Dionex CarboPac SA10-4µm column allows higher resolution separation of nine dominant sugars within 6 minutes. The method demonstrated excellent precision and accuracy, making it an ideal candidate for the fast analysis of coffee extracts to determine both the amount of free carbohydrates and total amount carbohydrates.

Dionex Integrion HPIC system

Read the full application update.

Beverages

Application summary AB 127

Determination of carbohydrates in fruit juice using capillary high-performance anion-exchange chromatography

Fei Pang, Terri Christison, and Linda Lopez, Thermo Fisher Scientific, Sunnyvale, CA, USA

Overview

High-performance anion-exchange chromatography (HPAE) coupled with pulsed amperometric detection (PAD) is a well-established technique to identify and quantify carbohydrates in food and beverage samples.

This application brief presents a method to simplify routine determination of carbohydrates in foods and beverages using a Thermo Scientific™ Reagent-Free™ ion chromatography (RFIC™) system.

Method

This method uses a Thermo Scientific™ Dionex™ ICS-5000 capillary IC system with automatic eluent generation and PAD.

Part Number	Description
072072	Thermo Scientific™ Dionex™ CarboPac™ PA20 capillary column, 0.4 × 150 mm

Conclusion

Glucose, fructose, and sucrose in fruit juices are well resolved following this method. Capillary RFIC systems expand and simplify the application of ion chromatography to routine carbohydrate analysis for the food and beverage industries by enhancing mass sensitivity, ease-of-use, and reproducibility.

Dionex ICS-5000+ Capillary HPIC system

Read the full application brief.

Beverages

Application summary AN 143

Determination of organic acids in fruit juices

Swati Gokhale and Jeff Rohrer, Thermo Fisher Scientific, Inc.

Overview

The presence and concentrations of organic acids determine tartness and other flavor attributes in fruit juices, and can also indicate juice freshness or spoilage. Organic acid profiles are distinct to juice type, so evidence of product adulteration can be evaluated by comparison against a known juice fingerprint.

This application note shows a method to determine organic acids in fruit juices at low to high mg/L concentrations.

Method

The study demonstrates determination of organic acids in orange, grape, apple and cranberry juices. It uses a simple dilution, and quantification on a Thermo Scientific™ Dionex™ ion chromatography system equipped with a high-capacity column and electrolytic eluent generation, with suppressed conductivity detection.

Part Number	Description
052960	Dionex IonPac AS11-HC column, 4 × 250 mm

Conclusion

This method is suitable for a variety of fruit juices. The electrolytic eluent generator creates high-purity, carbonate-free eluents to suppress baseline drift, and improve retention time and reproducibility. The Thermo Scientific™ Dionex™ IonPac™ AS11-HC column's high capacity improves separation of a wide variety of organic acids.

Thermo Scientific™ Dionex™ ICS-5000⁺ Capillary HPIC™ system

Read the full application note.

Beverages

Application summary AN 264

Fast determination of anthocyanins in pomegranate juice

Overview

Anthocyanins are a subclass of molecules known as flavonoids that are responsible for the brilliant red, orange, and blue colors of most fruits and flowers. Due to their strong antioxidant properties, anthocyanins are of considerable interest to the scientific community and consumer market. Products such as pomegranate juice that are valued for high anthocyanin content have become a target of food fraud.

This application note describes a sensitive, fast, and accurate method to determine anthocyanins in commercially available fruit juices using a simple dilution.

Part Number	Description
2.2 µm, 2.1 × 30 mm (P/N 071400) 2.2 µm, 2.1 × 50 mm (P/N 068981) 2.2 µm, 2.1 × 100 mm (P/N 068982) 2.2 µm, 2.1 × 150 mm (P/N 071399 2.2 µm, 2.1 × 250mm (P/N 074812) 2.2 µm, 3 × 30 mm (P/N 071606) 2.2 µm, 3 × 50 mm (P/N 071605) 2.2 µm, 3 × 100 mm (P/N 071604) 3 µm, 3 × 33 mm, (P/N 066272) 3 µm, 3 × 50 mm (P/N 068971) 3 µm, 3 × 75 mm, (P/N 066273)	Thermo Scientific™ Dionex™ Acclaim™ RSLC 120, C18 rapid separation column

Method

The method uses liquid chromatography on a high-resolution, rapid-separation column and absorbance detection at a visible wavelength of 540 nm to separate and detect anthocyanins in less than 5 minutes.

Conclusion

This work describes a sensitive and accurate method to separate and quantify anthocyanins in different fruit juices with a simple dilution of the sample.

Thermo Scientific™ Vanquish™ Flex Quaternary system

Read the full application note.

Beverages

Application summary AN 82

Analysis of fruit juices adulterated with medium invert sugar from beets

Overview

Fruit juice adulteration presents an economic and regulatory problem. The most common forms of adulteration include simple dilution and blending of inexpensive and synthetically produced juices into the more expensive ones. The source of sweetener can be other juices or sugar derived from fruits or vegetables.

This application note presents three methods of detecting several components in beet medium invert sugar (BMIS) that are not present in unadulterated orange juice.

Method	Part Number	Description
Method A	035391	2 Thermo Scientific™ Dionex™ CarboPac™ PA1 columns, 4 × 250 mm
Method B	035391	Dionex CarboPac PA1 column, 4 × 250 mm
Method C	043055	Thermo Scientific™ Dionex™ CarboPac™ PA-100 column, 4 × 250 mm

Method

Each method demonstrated uses high performance anion exchange chromatography with pulsed amperometric detection (HPAE-PAD) and is suitable for any Thermo Scientific™ Dionex™ chromatography system.

Conclusion

The selectivity of anion-exchange chromatography, especially for oligosaccharides, together with the sensitivity and specificity of pulsed amperometric detection make HPAE-PAD uniquely suited to this analysis. Any of these methods can be used to estimate adulteration levels above about 5%.

Thermo Scientific™ Dionex™ ICS-5000+ Capillary HPIC™ system

Read the full application note.

Beverages

Application summary TN 119

Fast separations of organic acids in an orange juice sample using high-pressure capillary IC

Terri Christison, Fei Pang, and Linda Lopez, Thermo Fisher Scientific, Sunnyvale, CA, USA

Overview

Determinations of organic acid profiles in fruit juices are used in the beverage industry to characterize flavor components, identify spoilage and potential sources of adulteration, and to meet labeling requirements for food products.

This technical note demonstrates the use of a high-pressure capillary Thermo Scientific™ Reagent-Free™ ion chromatography (RFIC™) system for fast analysis of organic acids in juice samples.

Method

In this study, inorganic anions and organic acids from a diluted orange juice sample are separated by anion-exchange chromatography on a Thermo Scientific™ Dionex™ ICS-5000⁺ HPIC Reagent-Free capillary IC system and detected by suppressed conductivity detection, using the Thermo Scientific™ Dionex™ ACES™ Anion Capillary Electrolytic Suppressor.

Part Number	Description
074246	Thermo Scientific™ Dionex™ IonSwift™ MAX-100 monolith column, 0.25 × 250 m
074247	Dionex IonSwift MAX-100 guard column
072076	Thermo Scientific™ Dionex™ EGC KOH capillary cartridge
072078	Thermo Scientific™ Dionex™ CR-ATC Capillary Continuously Regenerated Anion Trap column

Conclusion

The high-pressure method is shown to provide comparable results and the same advantages as standard pressure capillary IC, with low consumption of water (30 to 40 mL/day of water) and reduced waste generation, using a sample injection of only 0.4 µL.

Dionex ICS-5000⁺ Capillary HPIC system

Read the full technical note.

Beverages

Application summary AN 1095

Determination of dicyandiamide in milk powder

Chen Jing,[1] Dai Zhenyu,[1] Xu Qun,[1] Liang Lina,[1] and Jeffrey Rohrer[2]
[1]Thermo Fisher Scientific, Shanghai, People's Republic of China;
[2]Thermo Fisher Scientific, Sunnyvale, CA, USA

Overview

Dicyandiamide is used by farmers to minimize the environmental impact of livestock on land, by reducing the rate at which soil microbes convert ammonia from animal urine into nitrates and nitrous oxide, slowing nitrate leaching. Overuse of dicyandiamide can lead to its appearance in dairy products.

This application note demonstrates a straightforward method to quantify dicyandiamide with high sensitivity without the need for time-consuming sample cleanup.

Method

This study separates and quantifies dicynandiamide using ion-exclusion chromatography on a Thermo Scientific™ Dionex™ UltiMate™ 3000 Rapid Separation LC (RSLC) system with UV detection at 220 nm.

Part Number	Description
043197	Dionex IonPac ICE-AS1 analytical column, 9 × 250 mm

Conclusion

This simple HPLC method provides an excellent separation for the determination of dicyandiamide in milk powder samples. The separation power of the Thermo Scientific™ Dionex™ IonPac™ ICE-AS1 analytical & guard column simplifies the sample preparation process and eliminates the cartridge cleanup procedure, reducing analysis time and cost.

UltiMate 3000 Rapid Separation systems

Read the full application note.

Beverages

Application summary AN 248

Determination of lactose in lactose-free milk products by high-performance anion-exchange chromatography with pulsed amperometric detection

Pranathi Perati, Brian De Borba, and Jeffrey Rohrer, Thermo Fisher Scientific, Sunnyvale, CA, USA

Overview

Commercially available lactose-free products are produced by breaking down the primary milk sugar lactose—which can create gastric distress in intolerant individuals—into glucose and galactose by enzymatic hydrolysis. The resulting milk products contain varying amounts of residual lactose.

This application note presents a sensitive and accurate method to determine lactose and lactulose in dairy products, including lactose-free products.

Method

This study uses high-performance anion-exchange chromatography on a Thermo Scientific™ Dionex™ ICS-3000 system with direct detection by pulsed amperometric detection (HPAE-PAD) to quantify lactose in six different commercial products, four of which are lactose-free products.

Part Number	Description
043197	Thermo Scientific™ Dionex™ IonPac™ ICE-AS1 analytical column, 9 × 250 mm

Conclusion

This work describes a sensitive and accurate method to extract, separate, and quantify lactose and lactulose in milk-based products, in a separation time of less than 30 minutes.

Dionex ICS-5000+ Capillary HPIC system

Read the full application note.

Beverages

Application summary AN 231

Determination of melamine in milk by ion chromatography with UV detection

Overview

In 2008, melamine was found as a contaminant of milk and milk-containing products after the discovery of melamine contamination of pet food. Melamine was added to both products to increase their apparent protein content, as determined by a nonspecific total nitrogen test.

This application note shows how melamine can be determined in milk, powdered milk, and a milk-containing candy by cation-exchange ion chromatography (IC) on a Thermo Scientific™ Reagent-Free™ IC (RFIC™) system.

Method

This study separates and quantifies melamine using a Thermo Scientific™ Dionex™ ICS-3000 system with a Thermo Scientific™ Dionex™ IonPac™ CS17 column and UV detection at 240 nm on a PDA-3000 Photodiode Array Detector.

Part Number	Description
060557	Dionex IonPac CS17 analytical column, 4 × 250 mm
060560	Thermo Scientific™ Dionex™ IonPac™ CG17 guard column, 4 × 50 mm
046027	Thermo Scientific™ Dionex™ IonPac™ TCC-LP1 concentrator, 4 × 35 mm

Conclusion

This IC method accurately determined melamine in milk, milk powder, and a milk-containing candy after a simple sample preparation. As this method uses an RFIC system, the analyst does not have to prepare eluents and can easily change the mobile phase for samples where unknown peaks coelute with melamine.

Dionex ICS-5000+ Capillary HPIC system

Read the full application note.

Beverages

Application summary AN ANCCSCETMELCYAN

Analysis of melamine and cyanuric acid using a core enhanced technology accucore HILIC HPLC column

Joanna Freeke, Thermo Fisher Scientific, Runcorn, Cheshire, UK

Overview

In recent years there have been a number of food recalls relating to melamine adulteration. Cyanuric acid is a degradation product of melamine. Food safety regulatory bodies including the U.S. and Japan recommend the analysis of melamine and cyanuric acid using hydrophilic interaction (HILIC) HPLC separation prior to detection by mass spectrometry.

Method

This application note demonstrates the use of the Thermo Scientific™ Accucore™ HILIC HPLC column for the fast analysis of melamine and cyanuric acid without compromising backpressure.

Part Number	Description
17526-154630	Accucore HILIC 2.6 µm 150 × 4.6 mm column

Conclusion

The use of the Accucore HILIC column allowed the successful analysis of melamine and cyanuric acid giving good retention and separation at a back pressure suitable for use in a conventional HPLC system.

Thermo Scientific™ Vanquish™ Flex Quaternary system

Read the full application note.

Beverages

Application summary AN 20694

Determination of melamine in powdered milk by LC-MS/MS using a core enhanced technology solid core HPLC column

Kimberly Phipps, Thermo Fisher Scientific, Runcorn, Cheshire, UK

Overview

In recent years melamine has been found in adulterated milk and milk based products, including infant formula milk, causing thousands of children to become ill. Limits have now been set for the amount of melamine that can be present in foodstuffs; zero for infant formula milk, and 2.5 ppm maximum for other foodstuffs.

This application note presents an method for simple extraction and rapid quantification of melamine in infant formula.

Method

This study used solid-phase extraction on Thermo Scientific™ Ultra Vap hardware followed by liquid chromatography/mass spectrometry (LC-MS), using HILIC separation on a Thermo Scientific™ Accela™ 600 pump equipped with a Thermo Scientific™ CTC autosampler. Detection was performed on a Thermo Scientific™ TSQ Vantage™ mass spectrometer.

Part Number	Description
60107-303	HyperSep Retain-CX, 60 mg/3 m SPE cartridge
17526-102130	Thermo Scientific™ Accucore™ HILIC 2.6 µm, 100 × 2.1 m column

Conclusion

Using Thermo Scientific™ HyperSep™ Retain CX solid phase extraction cartridges sample preparation is fast and efficient giving an average recovery of 121 percent. The HILIC column provided a fast run time of 2 minutes. The method provided a linear dynamic range between 10 and 1000 ng/g with accuracies of +/- 20% for standards.

Thermo Scientific™ TSQ™ Triple Quadrupole LC-MS systems

Read the full application note.

Beverages

Application summary method TG 52251

Analysis of plasticizer contaminants in beverages and milk using an automated system based on turbulent-flow chromatography coupled to LC-MS/MS

Ebru Ates, Klaus Mittendorf, Thermo Fisher Scientific Food Safety Response Center, Dreieich, Germany

Overview

Phthalates have been used to deliberately adulterate beverages and sports drinks in Taiwan, and phthalates and other plasticizers are widely found as ubiquitous contaminants, particularly in fatty foodstuffs. Contamination arises from numerous sources such as the environment and food packaging.

Cross-contamination with phthalates can easily arise during trace analysis in the laboratory. A method for phthalates analysis is presented that minimizes sample handling through online automated analysis.

Method

This approach employs online Thermo Scientific™ TurboFlow™ chromatography for automated sample concentration, cleanup and analytical separation in a single run on a Thermo Scientific™ Transcend™ TLX liquid chromatography system. Identification of plasticizers is based on ion-ratios using selected reaction monitoring (SRM), on a Thermo Scientific™ TSQ Quantum™ Access MAX triple quadrupole mass spectrometer controlled by Thermo Scientific™ Aria™ software.

Part Number	Description
25003152130	Thermo Scientific™ Hypersil GOLD™ column, 150 × 2.1 mm 3 µm
CH953280	Thermo Scientific™ Turboflow™ C18 XL column, 0.5 × 50 mm

Conclusion

Online TurboFlow sample preparation coupled to LC-MS separation and detection enables very selective and effective determination of plasticizers. Elimination of time-consuming sample preparation steps provides high sample throughput while reducing the probability of sample contamination.

Transcend II system with multi-channel and TurboFlow technology

Read the full application note.

Beverages

Application summary AN 502

Simple and rapid screening of melamine in milk products with high resolution accurate mass benchtop orbitrap LC MS

Kefei Wang, Chunang (Christine) Gu, Thermo Fisher Scientific, San Jose, CA, USA

Overview

Generally used for industrial manufacturing, melamine, a nitrogen-rich white crystal, has been found as an adulterant used to falsify the protein levels in many milk products. Different countries vary in setting the Maximum Residue Limit (MRL) for melamine, but generally follow the United States Food and Drug Administration (US FDA) MRL of 1 ppm for infant formula and 2.5 ppm for other milk products.

This application note demonstrates a high-resolution benchtop liquid chromatography/mass spectrometry (LC-MS) method for simple and rapid monitoring of melamine in milk products.

Method

This study uses a Thermo Scientific™ Accela™ LC system and a Thermo Scientific™ Q Exactive™ Hybrid Quadrupole-Orbitrap™ mass spectrometer to screen trace levels of melamine in milk products.

Part Number	Description
73105-053030	Thermo Scientific™ BioBasic™ AX 3 × 50 mm, 5 µm column

Conclusion

This method rapidly analyzes infant formula and coffee creamers with a detection limit lower than 250 ppb, the reporting limit of quantitation (LOQ) set by the US FDA method for infant formula on a triple quadrupole mass spectrometer. Analysis required only a 1-minute, isocratic LC separation.

Q Exactive Hybrid Quadrupole-Orbitrap mass spectrometer systems

Read the full application note.

Beverages

Application summary AN 52087

Detection of ricin in milk using immunomagnetic separation (IMS) with surface-enhanced raman scattering (SERS) detection

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Overview

Ricin, a water-soluble protein toxin naturally present in the castor bean (R. communis), is considered a potential bioterrorism agent due to its toxicity, easy availability, simple and inexpensive production, and past history of use. Prior methods for detecting ricin are based on immune- or toxicity based methods, which, though sensitive to parts per billion and parts per trillion, are often time-consuming, labor intensive, unreliable, and/or expensive.

This application note combines two techniques to develop a method for fast, reliable, and economic determination of ricin in milk.

Method

This study combines immunomagnetic separation (IMS) and surface-enhanced Raman scattering (SERS) detection using a Thermo Scientific™ DXR™ Raman microscope equipped with Thermo Scientific™ OMNIC™ Array Automation software for the automated collection and processing of groups of samples.

Part Number	Description
10007D	Thermo Scientific™ Dynabeads™ Protein G Immunoprecipitation Kit

Conclusion

The combination of immunomagnetic separation with surface-enhanced Raman scattering can separate and detect the presence of ricin in milk with a detection limit of at least 4 micrograms per milliliter within a 20-minute time frame.

DXR 2 Raman microscope

Read the full application note.

Beverages

Application summary AN 10492

Chemical profiling and differential analysis of whiskies using Orbitrap GC-MS

Dominic Roberts,[1] Jana Hajslova,[2] Jana Pulkrabova,[2] and Paul Silcock[1]
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Overview

The complex, tradition-rich process of whiskey making results in a beverage that has both a high value and high degree of variability. Given the high retail price, counterfeiting and/or adulteration is commonplace. Whisky producers use analytical technology to accurately and comprehensively characterize their products both so that adulteration can be identified, and as part of quality control procedures to compare production batches and process over time.

This application notes demonstrates fast, robust methods to profile whiskey samples of different origins, ages and types by gas chromatography mass spectrometry (GC-MS).

Method

This study takes advantage of the performance of the Thermo Scientific™ TRACE™ 1310 gas chromatograph and Thermo Scientific™ Q Exactive™ GC Orbitrap™ GC-MS/MS system in combination with Thermo Scientific™ TraceFinder™ software and Thermo Scientific™ SIEVE 2.2 software to characterize nine whiskey samples. It evaluates the application of a complete untargeted chemometric workflow to detect and identify chemical components, and demonstrates a process to identify chemical differences in whiskies of different origins.

Part Number	Description
26096-1425	Thermo Scientific™ TraceGOLD™ TG-5SilMS 0.25 × 30 mm, 0.25 µm film capillary column with 10 m integrated guard

Conclusion

In this method, fast scan speeds in combination with a high in-scan dynamic range and high sensitivity facilitate the detection of both low and high intensity components. These features and unique software algorithms for automated deconvolution and sample comparison create a powerful solution for comprehensive characterization, quality control, and brand protection.

Q Exactive GC Orbitrap GC-MS/MS system

Read the full application note.

Beverages

Application summary AN 1068

Determination of organic acids in fruit juices and wines by high-pressure IC

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Overview

Organic acid profiles are monitored to determine authenticity, freshness and quality of fruit juices, wines, and other beverages. Organic acids influence the beverages' organoleptic properties (flavor, color, and aroma) as well as product stability and microbiological control.

This application note presents a method to determine organic acids in fruit juices and wines with high sensitivity and simple sample preparation.

Method

This study uses a Thermo Scientific™ Dionex™ ICS-5000⁺ HPIC™ system with suppressed conductivity detection to separate a large variety of organic acids with inorganic anions and detect them with high sensitivity while minimizing sugar interferences. The separation of 30 anions on the Thermo Scientific™ Dionex™ IonPac™ AS11-HC-4µm Capillary analytical and guard column (9 µm) and the Dionex IonPac AS11-HC-4 µm column sets are compared.

Part Number	Description
078035	Dionex IonPac AS11-HC-4 µm analytical column, 2 × 250 mm
078036	Dionex IonPac AS11-HC-4 µm guard column, 2 × 50 mm
052961	Dionex IonPac AS11-HC-9 µm analytical column, 2 × 250 mm
052963	Dionex IonPac AS11-HC-9 µm guard column, 2 × 50 mm
075778	Thermo Scientific™ Dionex™ EGC 500 KOH Eluent Generator cartridge
075550	Thermo Scientific™ Dionex™ CR-ATC 500 Continuously Regenerated Anion Trap column

Conclusion

This study presents characterization of ionic composition profiles and determination of organic acids in fruit juices and wines, with good accuracy and high sensitivity even for ions present in low concentrations. The Dionex IonPac AS11-HC-4 µm column set offers superior resolving power for separation of the target anions. The specificity and sensitivity of this method allow simple sample treatments without complex procedures such as extraction and/or derivatization.

Dionex ICS-5000⁺ Capillary HPIC system

Read the full application note.

Beverages

Application summary AB 30583

HPLC/EA-IRMS: Identifying adulterated coconut juice using isotope fingerprints

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Overview

The authenticity of commercially available coconut water is of increasing importance because of its designation as a juice by the European Fruit Juice Association (AIJN) and the increasing consumer perspective that it is a healthy, low-carbohydrate beverage. It has been noted that recent trends in addition of sugar to enhance taste and attractiveness of the coconut juice have resulted in an increased sale, however, opening the possibility to fraudulently mis-label coconut juice packaging with respect to the addition of sugar, meaning declarations such as “100% natural” would no longer be valid.

Method

The carbon isotope fingerprint ($\delta^{13}C$ values) of plants are different because photosynthetic processes and broadly grouped as C_3, C_4 and CAM plant types. Consequently, the $\delta^{13}C$ values of coconut juice is unique and distinguishable from sugar derived from sugar cane, for example. Coconut juice is extracted from the center of a coconut, which grow on coconut trees (Cocos nucifera) and are part of the C_3 plant family. Sugar derived from sugar cane (Saccharum spp.) are part of the C_4 plant family. It is known that C_3 plants have a carbon isotope fingerprint between -33‰ to -22‰[2,3] and C_4 plants have a carbon isotope fingerprint between -16‰ to -8‰[2,3], providing a framework to differentiate.

Part Number	Description
0723640	Thermo Scientific™ Flash IRMS Elemental Analyzer
0723654	Thermo Scientific™ DELTA™ V Advantage IRMS
1222750	Thermo Scientific™ Conflo IV Universal Interface

Conclusion

The detection of coconut juice adulteration by the addition of C_4-plant sugar can be significantly improved by using the carbon isotope fingerprint of specific sugars. It was demonstrated here that 9 out of the 24 tested samples (38%) taken from commercially available outlets, were adulterated.

Thermo Scientific™ EA IsoLink™ IRMS system

Read the full article here.

Beverages

Application summary AB 30477

GC-IRMS: Detecting purity and adulteration of tequila with isotope fingerprints

Dieter Juchelka, Mario Tuthorn and Christopher Brodie Thermo Fisher Scientific, Bremen, Germany

Overview

The blue agave (*Agave tequilana* Weber var. Azul) is a native plant of the Jalisco region, Mexico and is an important economic product that, by law, is the only one allowed to be used in the production of tequila. Tequila can come in two broad varieties: pure tequila, derived 100% from *A. tequilana*, or mixed tequila, deriving from *A. tequilana* with up to 49% sugar cane addition. Tequila is protected under the North American Free Trade Agreement (NAFTA) and local bilateral trade agreements, alongside the European Union Regulation (EC) 110/2008. Globally, tequila is a popular alcoholic beverage, which has led to increasing demand and thus production. This provides an opportunity of economically motivated fraud either by adulteration and mislabeling of original tequila or production of fake tequila.

Part Number	Description
0722659	Thermo Scientific™ GC IsoLink II System
0723704	Thermo Scientific™ DELTA™ V Plus IRMS
1222750	Thermo Scientific™ Conflo IV Universal Interface
BRE0011976	Thermo Scientific™ TriPlus™ RSH™ Autosampler

Method

Photosynthetically, *A. tequilana* is part of the CAM plant group, meaning it has a well-defined carbon isotope fingerprint of -12‰ to -14‰. During plant growth, the water that comes principally from rainfall is used.

Because Tequila is produced exclusively in certain regions of Mexico the oxygen isotope fingerprint of the A. tequilana plant, and of the local sugars used in mixed tequilas, is primarily given by the rainfall water in those regions and therefore can provide a geographical tool for origin.

Conclusion

The carbon and oxygen isotope fingerprint plot allows differentiating the original branded mixed tequila from *A. tequilana* and sources of sugar (corn and cane). This indicates that mixed tequila can be clearly differentiated from pure tequila.

Thermo Scientific GC IsoLink IRMS System

Read the full article here.

Beverages

Infographic

Full infographic

Beverages

Application summary AN 30461

GasBench II System: Tracking wine adulteration using oxygen isotope fingerprints

Jens Radke, Christopher Brodie Thermo Fisher Scientific, Bremen, Germany

Overview

The most common type of wine adulteration is the addition of cheaper products to the original wine, such as fruit juices, water and sweeteners, which are not related to the grapes or fermentation process that the wine was originally produced from. Another example of fraud is re-labeling of wines, by adding the label of a more expensive wine to a bottle of a different, cheaper version and selling it on the market as an original product. European Commission Regulation (EC) No 607/2009 regulates the origin and labelling of wine, with bilateral agreements in place with Australian, Mexico, Chile, USA, Croatia, Switzerland, amongst others.

Method

Oxygen isotope fingerprints can be used to identify the geographical origin of wine. The grapes, from which wine is produced, carry a fingerprint derived from local-regional rainfall, but that can also be influenced by cultivation practices, soil processes and geological characteristics of the local area, altitude and proximity to the shoreline. This study shows how wine adulteration by the addition of water can be detected by the change in the oxygen isotopes.

Part Number	Description
0723654	Thermo Scientific™ DELTA™ V Advantage IRMS
0722264	Thermo Scientific™ GasBench II System

Conclusion

The correct labeling of wine affects producer and consumer value and food safety. Laboratories require an analytical technique providing conclusive answers on origin and authenticity of primary ingredients.

The oxygen isotope fingerprint of wine allows the identification of water addition in commercial wine, i.e. adulteration. This helps protect producer reputation and consumer confidence by detecting fraudulent activity and supports (EC) No 606/2009.

Thermo Scientific™ GasBench II system

Read the full article here.

Menthol

Application summary AB 30674

GC-IRMS: Differentiating natural and synthetic sources of menthol by carbon and hydrogen isotope fingerprints

Mario Tuthorn[1], Dieter Juchelka[1] and Philippe Merle[2], [1]Thermo Fisher Scientific, Bremen, Germany; [2]Firmenich, Corporate R&D, Innovation in Analytical Chemistry, Geneva, Switzerland

Overview

Menthol is a basic ingredient of mouth fresheners, food, chewing gums, fragrances, cosmetics, tobacco, pharmaceuticals, and many more products which are widely used in everyday life. Menthol can be obtained from natural sources, e.g. from mint oil produced by steam distillation of Mentha arvensis, or it can be made synthetically through different synthetic pathways. Menthol price and availability fluctuate depending on the climate conditions which influences the economy of the major producers of mint oil in the world, requiring a reliable solution to prevent false labelling of products containing menthol to protect both consumers and producers.

Method

Menthol has a fingerprint, a unique chemical signature that allows it to be identified. The carbon isotope fingerprints ($\delta^{13}C$) of different plant groups vary because of photosynthetic processes and environmental conditions. Hydrogen fingerprint is associated with local-regional rainfall, and can also be influenced by cultivation practices, soil processes and geological characteristics of the local area. By combining the carbon and hydrogen isotope fingerprints, menthol source can be assessed.

Part Number	Description
0722659	Thermo Scientific™ GC IsoLink II System
0723704	Thermo Scientific™ DELTA™ V Plus IRMS
1222750	Thermo Scientific™ Conflo IV Universal Interface
BRE0011976	Thermo Scientific™ TriPlus™ RSH™ Autosampler

Conclusion

In this study, 10 menthol samples were analysed for determination of carbon and hydrogen isotope fingerprints. By combining carbon and hydrogen isotope data in two dimensional XY plot, naturally and synthetically obtained menthol were clearly differentiated. This provides a platform for source identification of different sample types containing flavors, which are widely used in foods, pharmaceutical and cosmetics industry.

Thermo Scientific GC IsoLink IRMS System

Products highlighted in the applications

Thermo Scientific™ UltiMate™ 3000 Rapid Separation system

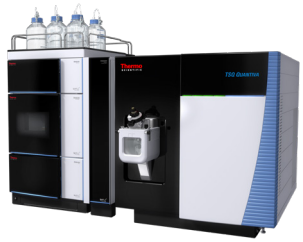
Thermo Scientific™ Vanquish™ Flex Quaternary system

Thermo Scientific™ Q Exactive™ GC Orbitrap™ GC-MS/MS system

Thermo Scientific™ GC IsoLink II™ IRMS System

Thermo Scientific™ EA IsoLink™ IRMS system

Thermo Scientific™ LC IsoLink™ IRMS System



Thermo Scientific™ TSQ™ Triple Quadrupole LC-MS system

Thermo Scientific™ Q Exactive™ Hybrid Quadrupole-Orbitrap™ MS systems

Thermo Scientific™ Dionex™ Integrion™ HPIC™ system

Thermo Scientific™ Dionex™ ICS-5000+ Capillary HPIC™ system

Thermo Scientific™ Transcend™ II system with Multi-channel and TurboFlow™ Technology

Thermo Scientific™ DXR™ 2 Raman microscope

Other resources

Type			Title	Category	Resource
Application notebook	Adulteration and authenticity	General	Chromatography for Foods and Beverages: Adulteration and Authentication Applications Notebook	IC + LC	AI71475
Brochure	Halal foods	Halal foods	Solutions for food safety, quality, and halal testing		BR63865
Application notebook	Adulteration and authenticity	Additives	Chromatography for Foods and Beverages Flavors, Colorants and Additives Analysis Applications Notebook	All	AI71472
Application notebook	Adulteration and authenticity	Contaminants	Chromatography for Foods and Beverages: Contaminants Applications Notebook	All	AI71476
Application notebook	Adulteration and authenticity	Beverages	Chromatography for Profiling Beverages Applications Notebook	All	AI71474
Application notebook	Authenticity	Wine	Application Note: Application Summary Compendium – Wine should ONLY be Wine		AI72110
Application notebook	Authenticity	Wine	Wine Analysis: from 'Grapes to Glass' – An Analytical Testing Digest of the Wine Manufacturing Process	All	XX72102
Application notebook	Authenticity and adulteration	Oils	Chromatography for Foods and Beverages - Fats and Oils Analysis Applications Notebook	All	AI71471
Poster note	Adulteration	General	A Turn-key System for Automated Detection of Organic Contaminants in Food Matrices and Economic Adulteration	LC- HRAM	
Poster note	Adulteration	Fruits	Determination of Organic Acids and Anthocyanins in Cranberry Extract	IC + LC	PN70227
Case study	Authenticity and adulteration	Honey	Case Study: Simplicity Achieved for Testing Honey in a South African Contract Laboratory	LC-CAD	CS71815
Poster note	Authenticity	Oils	Characterization of Used Cooking Oils by High Performance Liquid Chromatography and Corona Charged Aerosol Detection	LC-CAD	PN70536
Poster note	Authenticity	Oils	Determination of Olive Oil Adulteration by Principal Component Analysis with HPLC–Charged Aerosol Detector Data	LC-CAD	PN70689
Poster note	Adulteration	Juice	Evaluation of Herb and Fruit Juice Adulterationand and Authenticity by Coulometric Array Detection and Pattern Recognition Analysis	LC	PN70534
Poster note	Adulteration	Juice	Using Capillary IC with Suppressed Conductivity and Charge Detection to Profile Organic Acids in Juices and Beverages	IC	PN71719
Smart note	Authenticity	General	How can stable isotopes be used to determine origin and authenticity of food and beverage products?	IRMS	SN30410
Smart note	Authenticity	General	Are there official methods for food and beverage product origin, authenticity and label claims?	IRMS	SN30414

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