

Improving a Labs Turn Around Time and Pesticide Data Quality with Workflow Automation

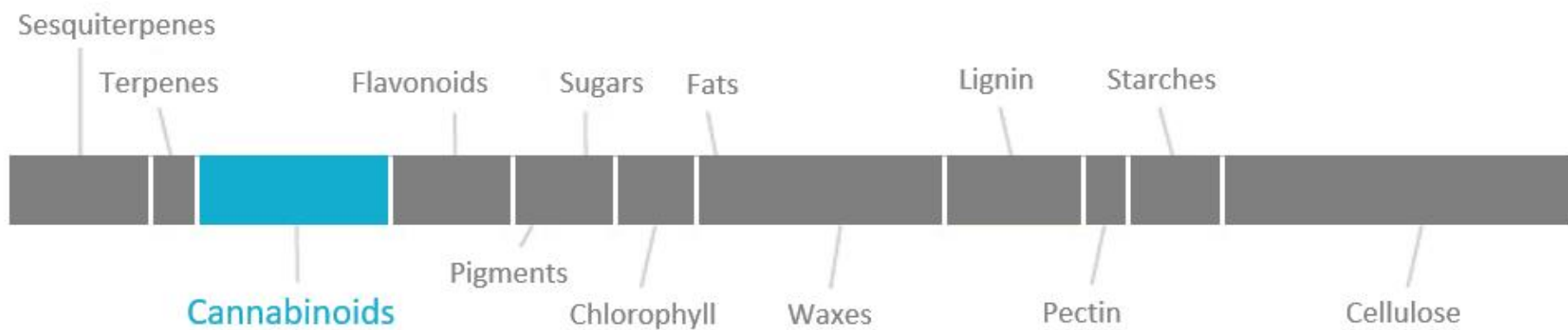
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Global Market Manager – Cannabis & Hemp

June 3rd 2020



Cannabis Has Complex Chemistry



Seed to Sale of Cannabis Products



Cultivation



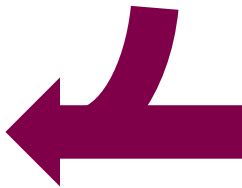
**Harvesting/
Trimming**



Extraction



Distillation & Purification

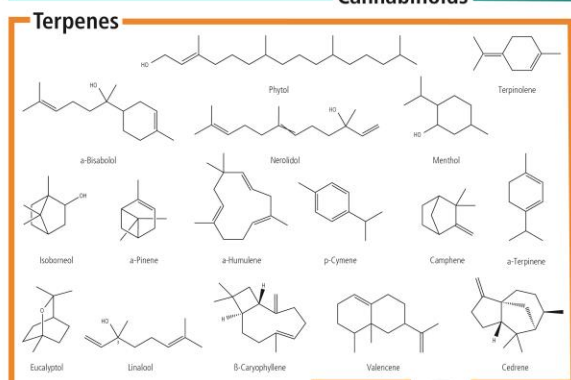
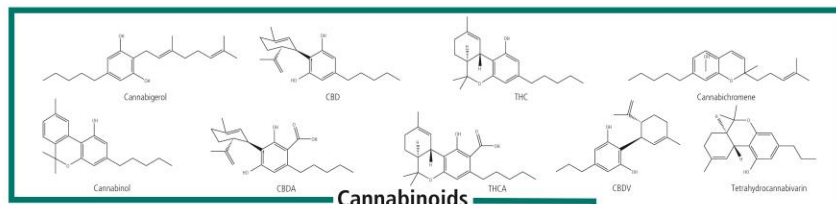


Raw Ingredients

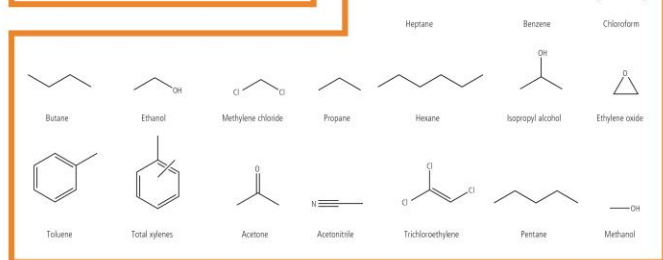
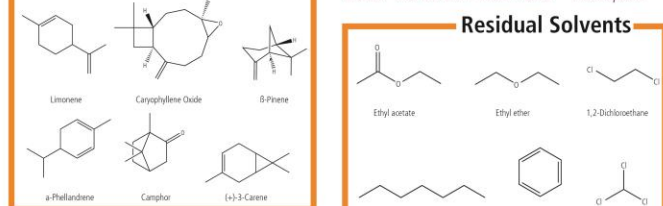


Infused Product

Chemistry Overview



Clarus® GC/MS with TurboMatrix™ Headspace



FLEXAR™ LC

THE CHEMISTRY OF CANNABIS

For years, PerkinElmer has worked with cannabis & hemp laboratories to develop industry-leading methods, technology, and exceptional return on investment. Whether your lab is well-established, or just starting up, having a single-source partner who can offer turnkey solutions that meet state and regional regulations is essential to a successful business.

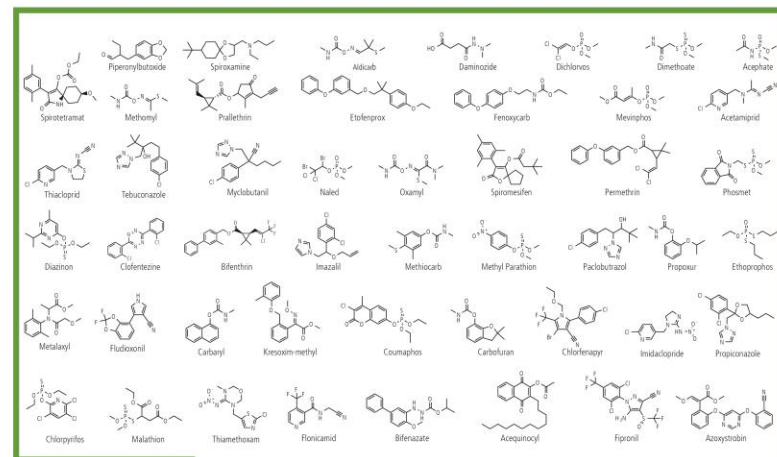
Learn about our various testing methods and applications for cannabis analyses by visiting:
www.perkinelmer.com/cannabis
 or calling: 1 (800) 762-4000



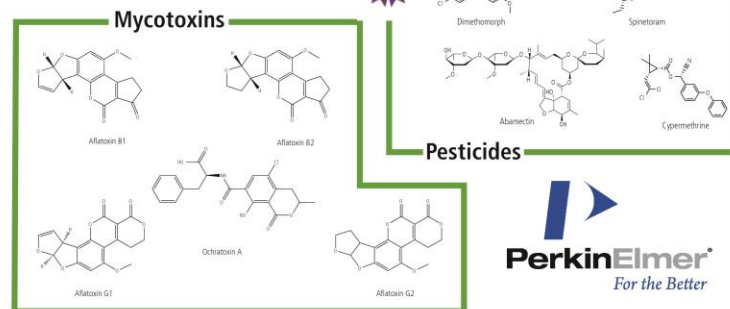
NexION® 2000 ICP-MS

As Arsenic	Cd Cadmium
Hg Mercury	Pb Lead

Heavy Metals



Q-Sight® 420 LC/MS/MS



Part 1: Pesticide Analysis in Cannabis is Challenging

- Complex matrix associated
- Broad Interference from Cannabinoids present in wt % range.
- Terpenes and other non-cannabinoids compounds are present in high ppm
- Pesticides in 1.0 -1000 ppb



STANDARD OPERATING PROCEDURES

A Practical Approach to the Analysis of Pesticides & Mycotoxins in Cannabis Extract for California & Oregon QSight 420

HIGHLIGHTS

Equipment & Standards on page 2

Experimental Procedure on page 4

LC/MS/MS Configuration on page 7

Method Validation & Typical Results on page 10

Appx: Sample Recovery Data on page 16

Appx: Recommended Internal Standards on page 19

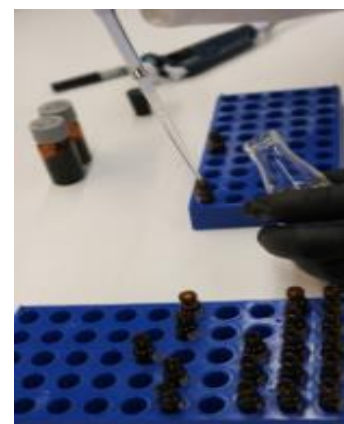
Recently, demand for the accurate quantification of pesticides in cannabis has increased, particularly among cannabis industry stakeholders and government regulatory institutions. This is due to both the complexity of preparing the cannabis matrix for pesticide analysis, and the increasingly stringent pesticide limits for cannabis products in certain states.

This document is intended to prepare your lab personnel to perform the series of analytical methods necessary for the complete analysis of pesticides in cannabis extracts and concentrates for California and Oregon. The methods described here will ensure that your lab attains the limits of quantitation specified for each relevant pesticide and mycotoxins below prescribed action limits by California and Oregon State.

The procedures included provide for the effective, reliable, and accurate quantitation of all pesticides listed by the *Bureau of Cannabis Control* (the proposed text of the regulations for California and Oregon). The analytical methods target pesticides and mycotoxins in cannabis extract using the PerkinElmer LX-50 LC (*Liquid Chromatograph*) for effective separation and QSight® 420 tandem MS (*Mass Spectrometer*) for accurate quantitation.



LC/MS Pesticide Method Prep

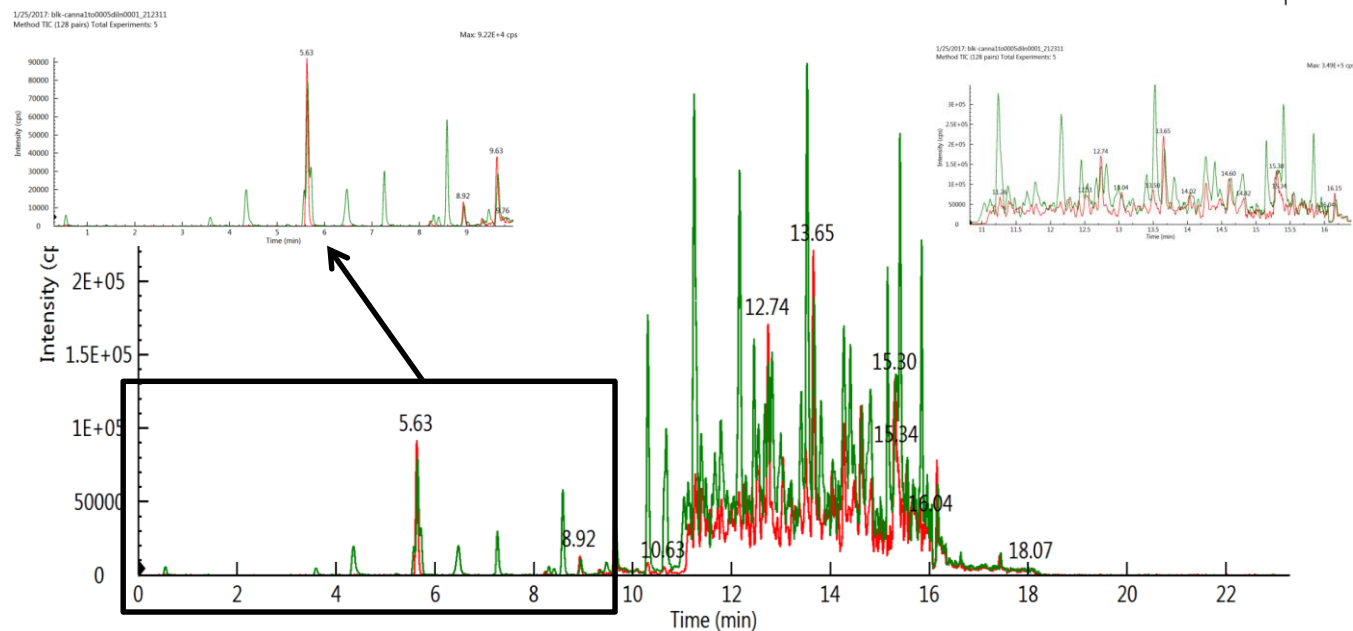


- No Quechers or No SPE Needed
- One instrument – QSight 420 LC/MS-MS

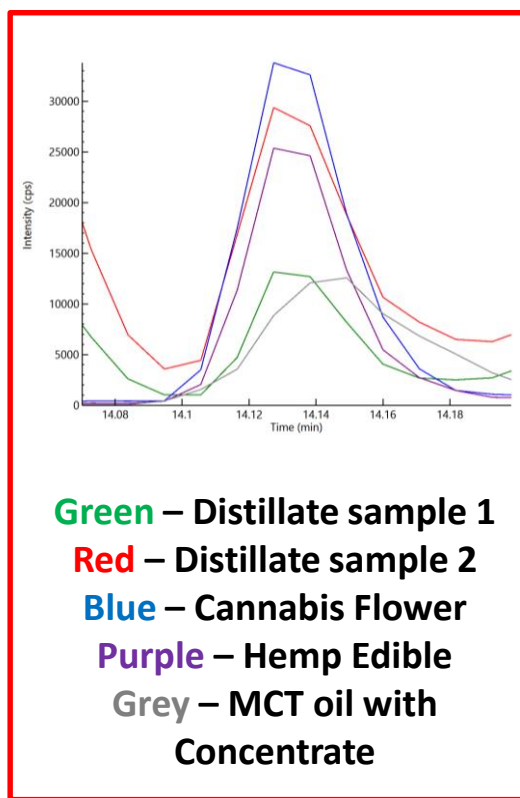
Influence of Cannabis Sample Matrix

1/25/2017: blk-canna1to0005diln0001_212311
Method TIC (128 pairs) Total Experiments: 5

— Cannabis extract (1 to 5 diluted) spiked with 25 ppb pesticide mix
— Cannabis extract (1 to 5 diluted) Max: 2.36E+5 cps



TIC overlay shows easy detection of 25 ppb spike of pesticides mix in cannabis extract



Understanding Challenging Pesticides - PCNB

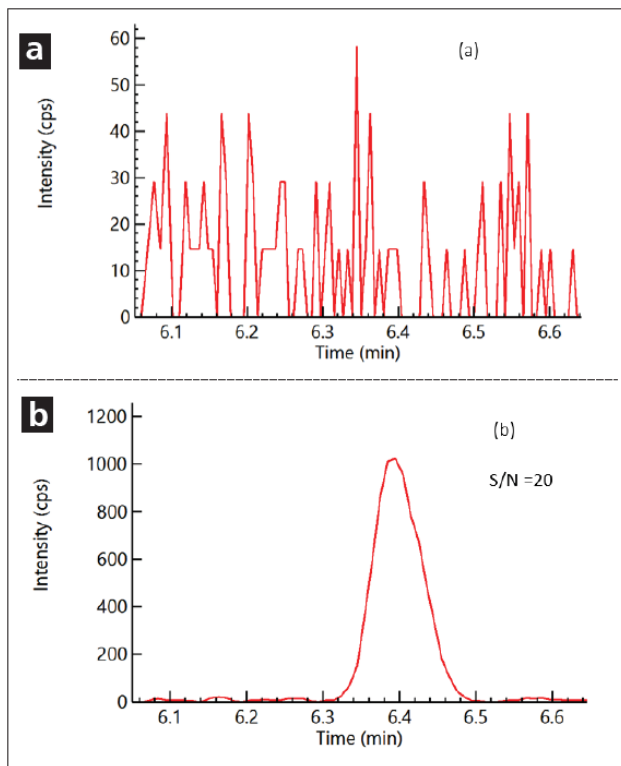
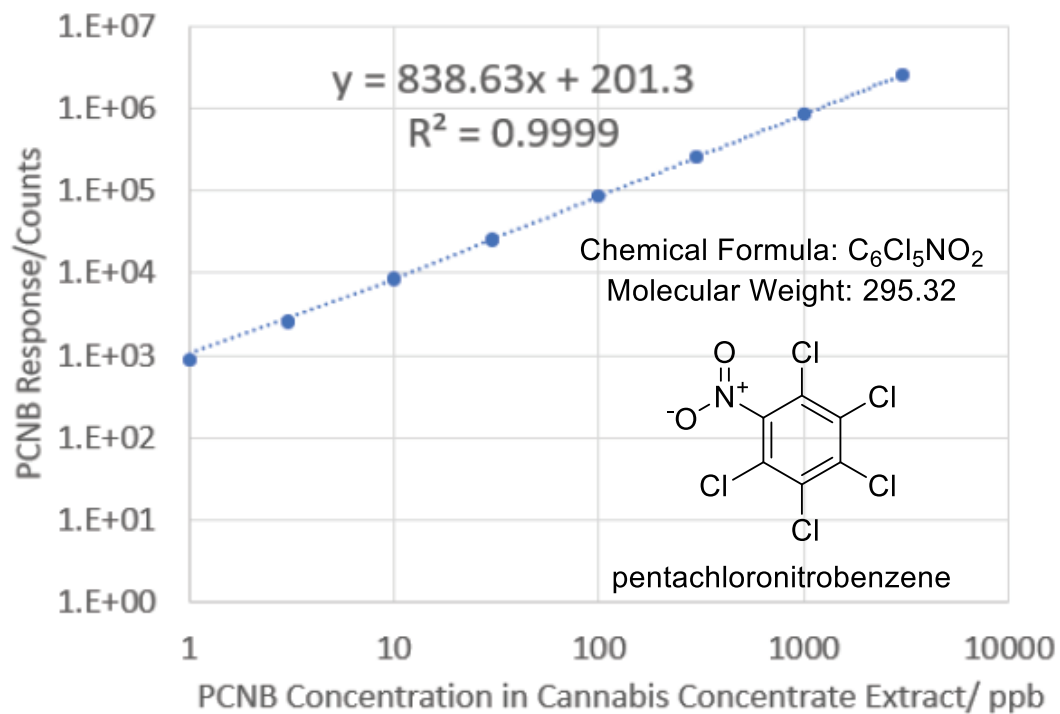


Figure 4. PCNB response in a blank cannabis concentrate matrix (a), and from spiked level of 0.1 µg/g in cannabis concentrate matrix (b).



- Selective
- Linear
- Sensitive





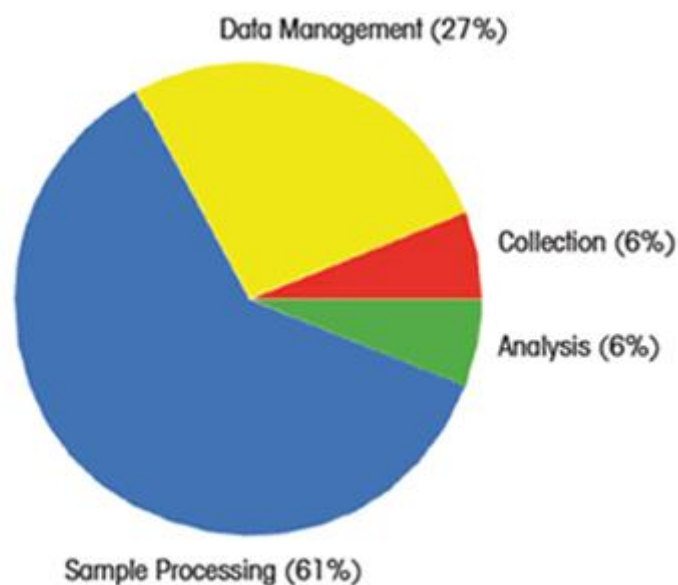
Time



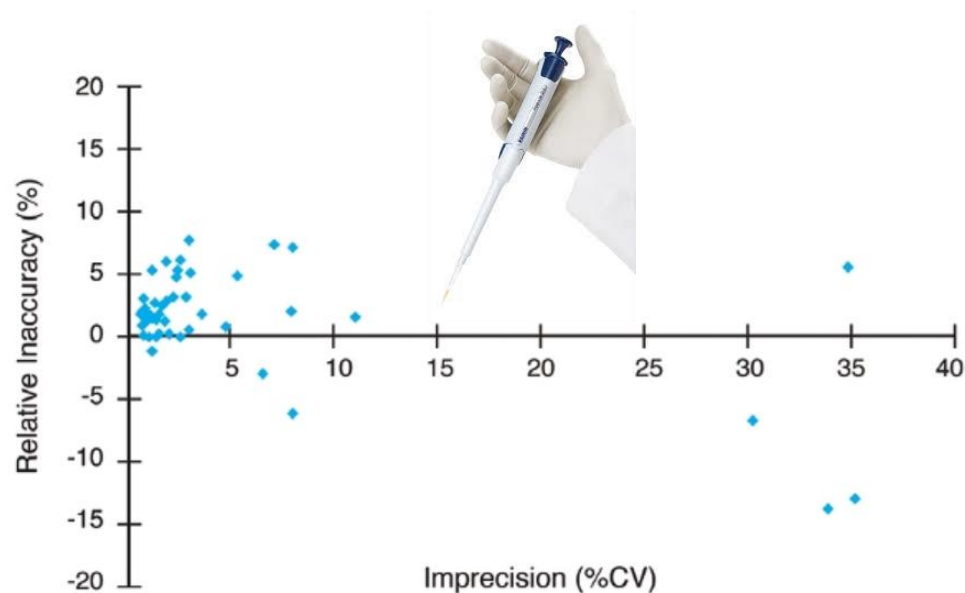
Data Quality

Sources of Experimental Variability

Time Spent in Lab



Pre-Training Pipette Skills Assessment²



1. https://www.mt.com/ca/en/home/perm-lp/product-organizations/labtec/Competence/sample_preparation.html

2. <https://www.americanlaboratory.com/914-Application-Notes/156964-Improved-Pipetting-Technique-An-Out-of-the-Box-Solution-to-Reduce-Manual-Pipetting-Errors/>

Part 2: Adding Automation to improve Cannabis Testing

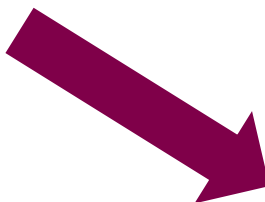


Janus Liquid Handler



GC/MS – Headspace

- Residual Solvents
- Terpenes & Flavonoids



HPLC

- Potency

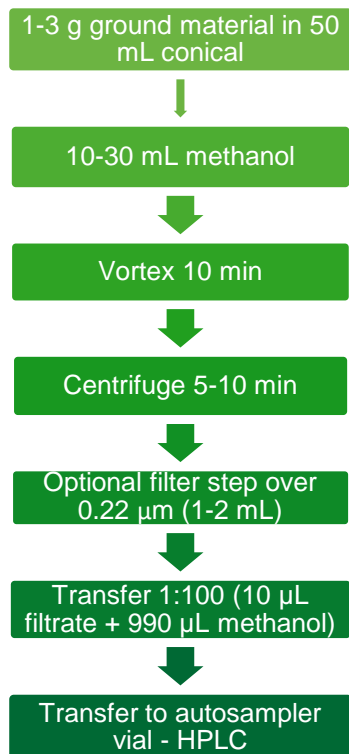


LC-MS/MS

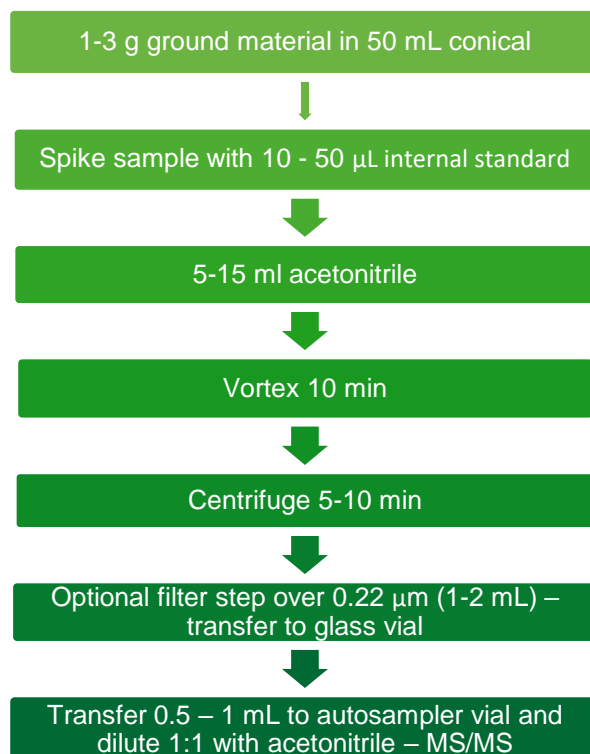
- Pesticides
- Mycotoxins

Automation for cannabis testing Analytical Workflows

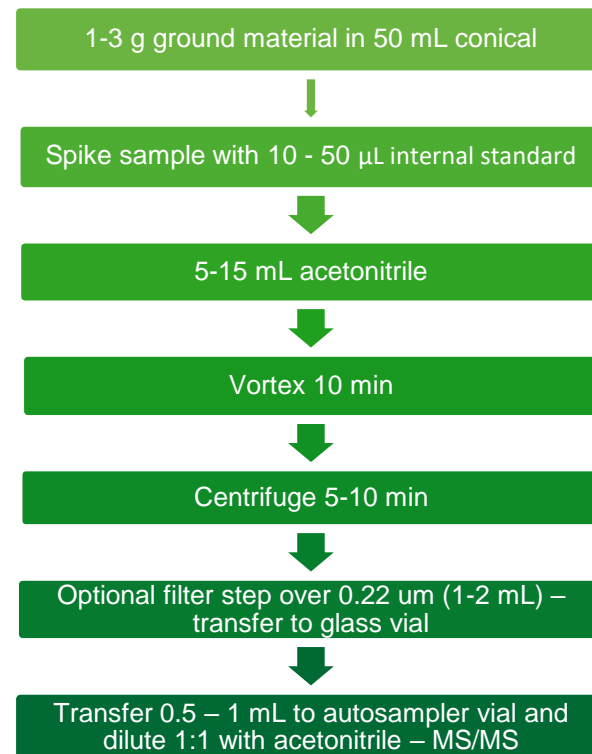
Potency



Pesticide Residue

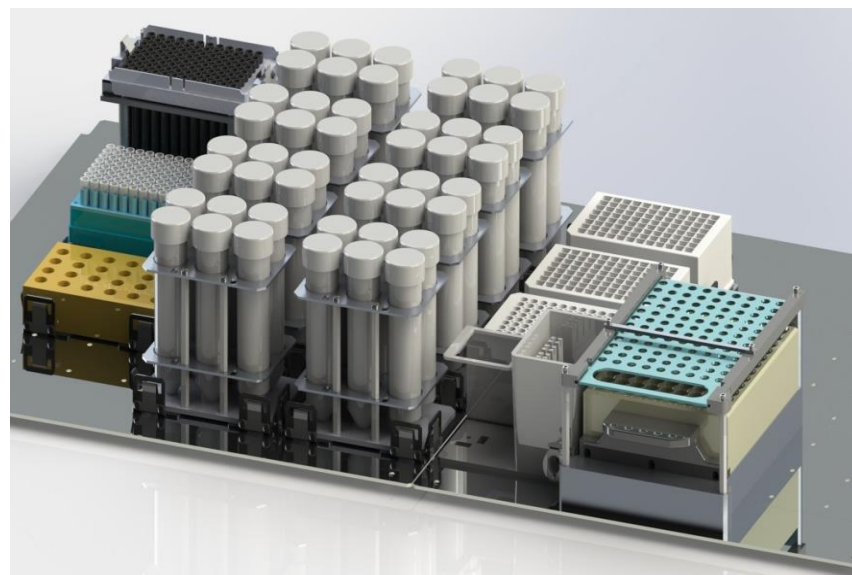
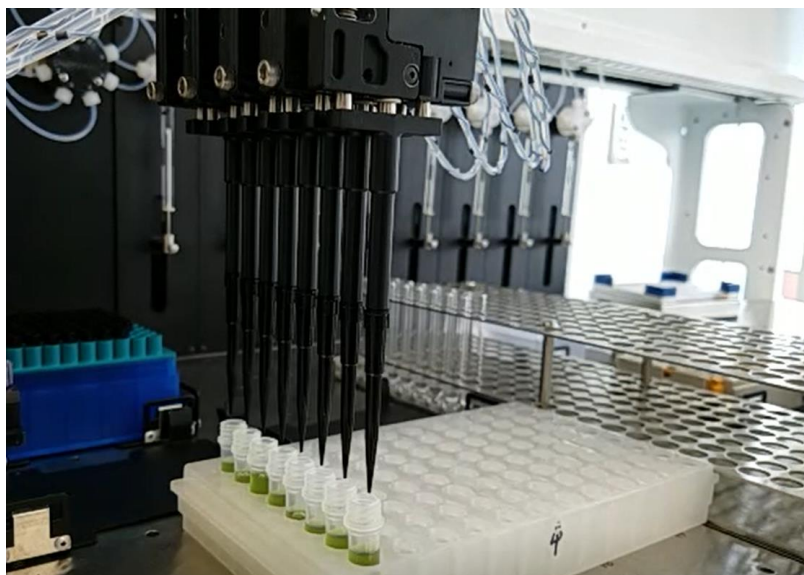


Mycotoxin



Automated sample prep for cannabis testing

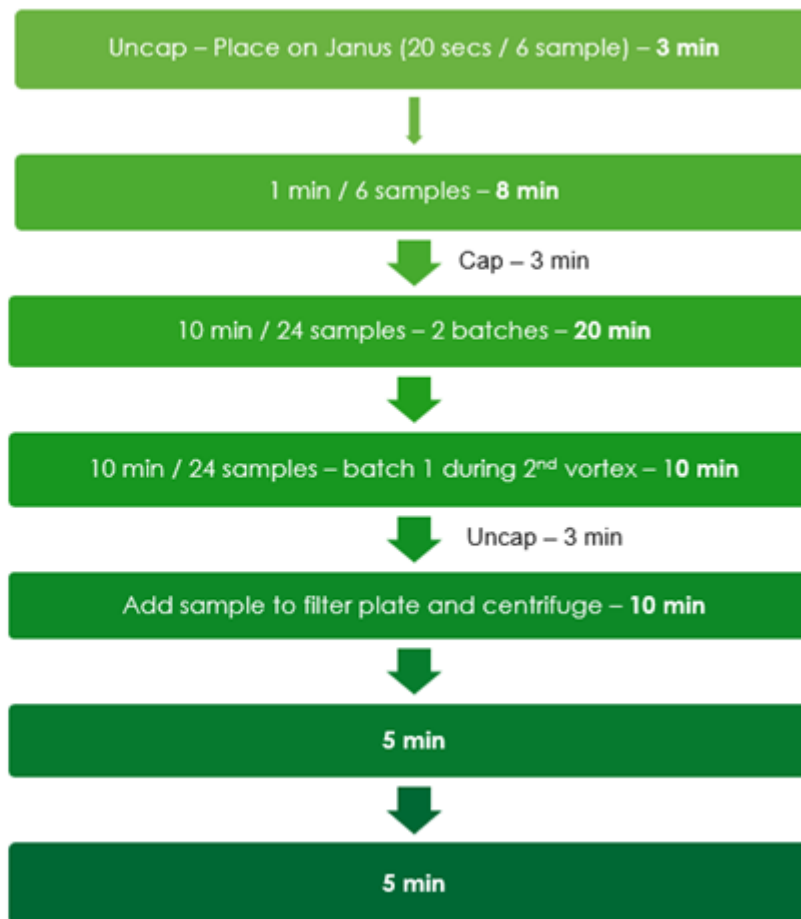
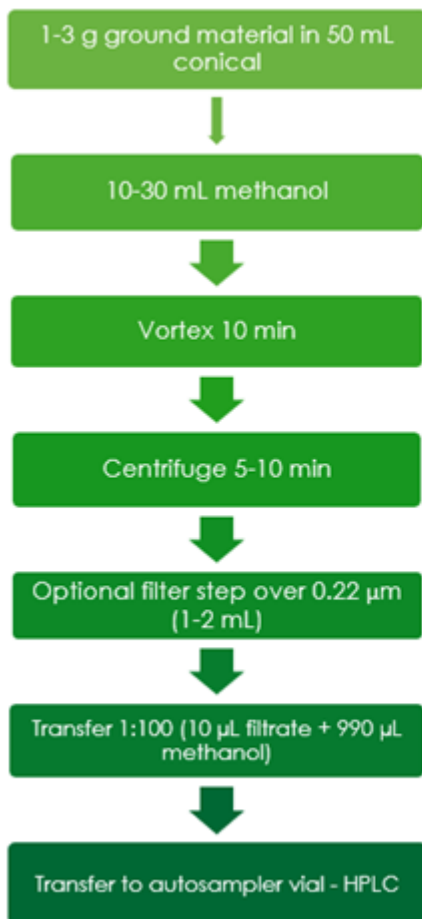
Cannabis potency analysis · Pesticide analysis · Mycotoxin testing



- **Barcode Scanning**
- **High volume solvent addition**
- **Standard addition**
- **Serial Dilution**



Time Savings



Pesticide and Mycotoxin
1 hour 7 min
48 Sample

Available Application Collateral



APPLICATION NOTE


Liquid Chromatography

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Cannabinoid Monitoring in a Variety of Edibles by HPLC-PDA

Introduction
Current needs for the analysis of the cannabis content in commercially available food products present a challenge. Since the fortification of cannabinoid compounds has been applied to a diverse spectrum of matrices, including high sugar, high fat matrices, which can make sample preparation particularly demanding.

This application describes the sample preparation and analytical method for the chromatographic separation and quantitative monitoring of twelve primary cannabinoids in the extracts of dried food matrices by HPLC, using a photodiode array (PDA) detector. The structures for these cannabinoids are shown in Figure 1.


APPLICATION NOTE

FT-IR Spectroscopy

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The Determination of Total THC and CBD Content in Cannabis Flower by Fourier Transform Near Infrared Spectroscopy

Introduction
The medicinal use of cannabis and cannabinoid products has experienced exponential growth over the past decade. Canada, Germany, New Zealand and Colombia now have legal considerations. In the United States, 10 states plus the District of Columbia have passed legislation permitting the use of medicinal cannabis. Of these 10 states, nine have been permitting the use of recreational cannabis. As the industry moves toward legalization, understanding the cannabinoid concentrations along the cultivation and processing path is critical for ensuring the quality and safety of cannabis products.





APPLICATION NOTE

FT-IR Spectroscopy

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Optimization of the Decarboxylation Reaction in Cannabis Extract

Introduction
The production of cannabis extracts and oils for medicinal and recreational products has increased significantly in North America. This growth has been driven by both market demand in newly regulated states and patient demand for a greater diversity in cannabis products. Total cannabinoid reduction processes, independent of solvent or application choice, undergo a decarboxylation step where the carboxylic acid functional group is removed from the cannabinoids. The decarboxylation reaction converts the naturally occurring acid forms of the cannabinoids, e.g. tetrahydrocannabinolic acid (THCA) and cannabidiolic acid (CBDA), to their more potent neutral forms, e.g. tetrahydrocannabinol (THC) and cannabidiol (CBD). Because the carboxylic acid group is thermally stable, the industry typically applies a heat source, and at times a catalyst, to decarboxylate the cannabinoids.


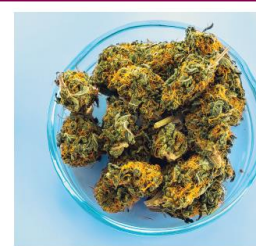
APPLICATION NOTE

Liquid Chromatography/Mass Spectrometry

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A Single Cannabis LC/MS/MS Method to Meet California Pesticide and Mycotoxin Residues Regulatory Requirements

Introduction
Over half of the U.S. has legalized the use of medical cannabis due to its therapeutic benefits for ailments such as cancer, multiple sclerosis, and ALS.¹ Like traditional agriculture crops, pesticides are sometimes used in cannabis cultivation to protect plants from pests and improve growth yield. Chronic exposure to pesticides can pose serious health risks; therefore, pesticide analysis in cannabis is an important consumer safety topic. Recent news has reported an alarming percentage of cannabis products to be tainted by high levels of pesticide residue, prompting recalls and public safety alerts. Banned pesticides like imidacloprid, imidacloprid, alachlor, chlorpyrifos, and spinosad, have been detected as residues on cannabis flowers and concentrated further in extracts and edibles. A case in Colorado recalled 20,000 packages of cannabis flowers in October 2015 due to pesticide contamination, and in November 2016, Oregon officials issued a health alert for specific batches of cannabis. Moreover, many of today's cannabis products are infused after combining them, so there is growing concern among consumers and regulators due to the unknown effects of pesticide compounds when infused.²⁻⁴ In addition to pesticides, the growing conditions for cannabis are also conducive to the growth of molds and fungi which can produce carcinogenic mycotoxins including aflatoxin A and aflatoxin B. As a result, testing for the levels of pesticide and mycotoxins in cannabis is important to ensure consumer safety and quality control.

APPLICATION NOTE


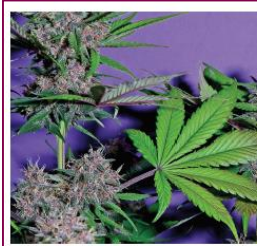
ICP-Mass Spectrometry

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Digestion, Testing, and Validation of Heavy Metals in Cannabis

Introduction
Owing to the toxicity of heavy metals, it is increasingly important to test cannabis flowers and other cannabis derivatives so that patient and consumer safety is maintained as the use of cannabis becomes more common. This need has translated into an increasing demand for testing cannabis flowers and other cannabis derivatives for toxins such as the heavy metals cadmium (Cd), lead (Pb), arsenic (As), and mercury (Hg). Similar to federal pharmaceutical and nutraceutical requirements in the U.S.,¹ states like California,² Oregon, and Colorado have published action limits for heavy metals.

Each jurisdiction where cannabis is permitted has published required maximum allowable heavy metals in cannabis and related products. Many of these limits are based on USP <232> or CDQ recommendations. The limits differ based on the route of administration, similarly to what is set out in the CDQ recommendations. Currently, Canada has not set regulations around metals in cannabis products, but is relying on USP <232> and <233> for guidance. Some of the currently known limits for heavy metals are provided in Table 1. For the purpose of this study, the California limits on "all inhaled cannabis goods" were used as they are the most stringent and most applicable to cannabis flower.

APPLICATION NOTE


Gas Chromatography/Mass Spectrometry

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Fast, Accurate, and Precise Terpene Testing of Cannabis Samples

Introduction
Like all botanicals and plants found in nature, cannabis also contains terpenes, which are the aromatic oils that give rise to the distinctive flavors and aromas found in cannabis varieties. There have been up to 140 different types of terpenes reported in cannabis, but multiple studies suggest that approximately 17 are the most common and can be used for examining their chemotype. Chemotype, those strains that have chemical properties that differ from each other.¹ Among them are monoterpenes, diterpenes, and sesquiterpenes, which are characterized by the number of repeating units of a five-carbon isoprene, called isoprene, the structural hallmark of all terpenoid compounds.

The diverse palette of cannabis terpenes is impressive enough, but arguably the most fascinating characteristic is their ability to interact synergistically with other compounds in the plant, the cannabinoids. In the past few decades, a significant amount of work has been performed to understand the "entourage effect", which scientists refer to as synergistic interaction between terpenes and cannabinoids in the human body. This effect is believed to magnify the therapeutic benefits of the plant's individual components – so that the medicinal impact of the whole plant is greater than the sum of its parts quantifying which terpenes are present is an important aspect of understanding the unique effects of cannabis for both medicinal and recreational users.



Summary

- Cannabis is a challenging matrix to test
 - Matrix heavily influences method
- LC/MSMS can be used to test for all pesticides in cannabis and hemp
- PerkinElmer's Automation improves data quality and TAT
- PerkinElmer is excited to work with the Scientific community to drive Cannabis & Hemp Science

THE COMPLETE CANNABIS LAB SOLUTION



Q&A

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