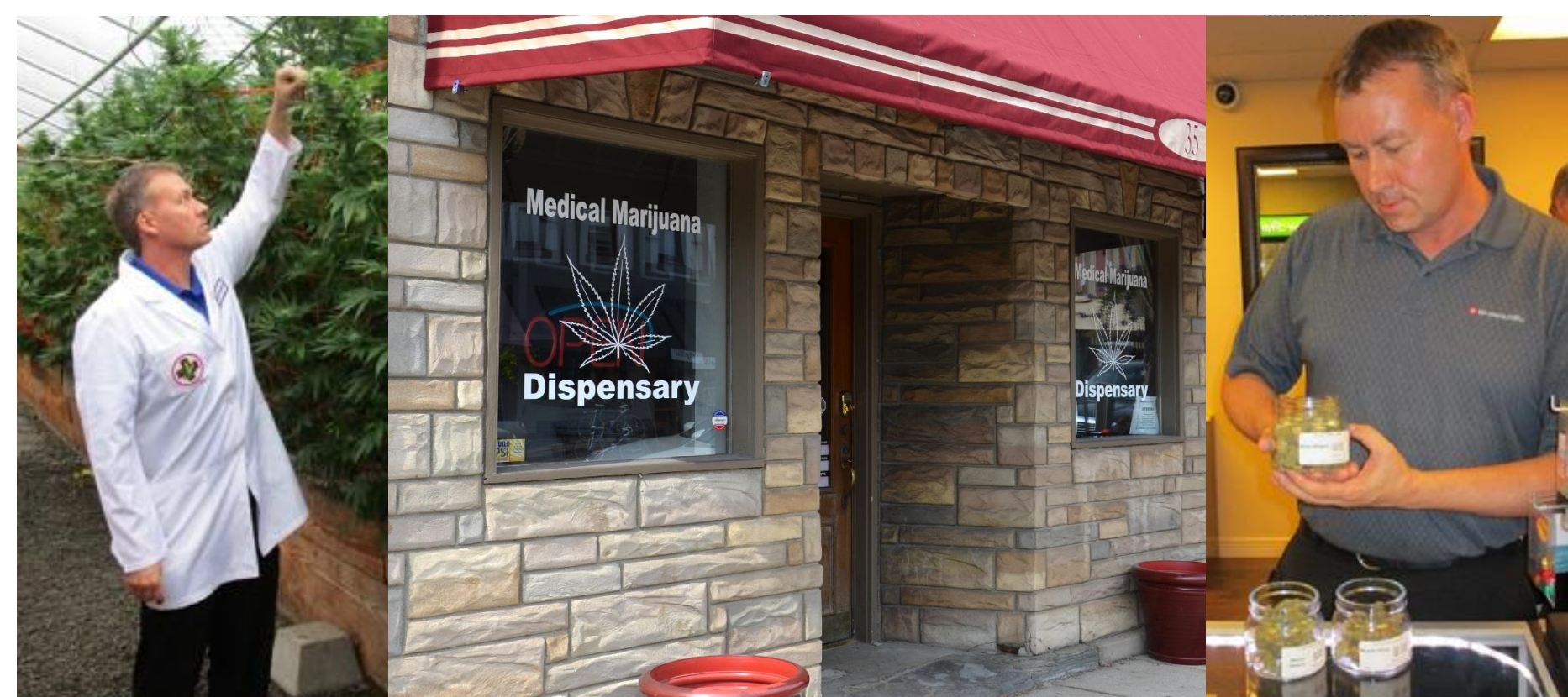




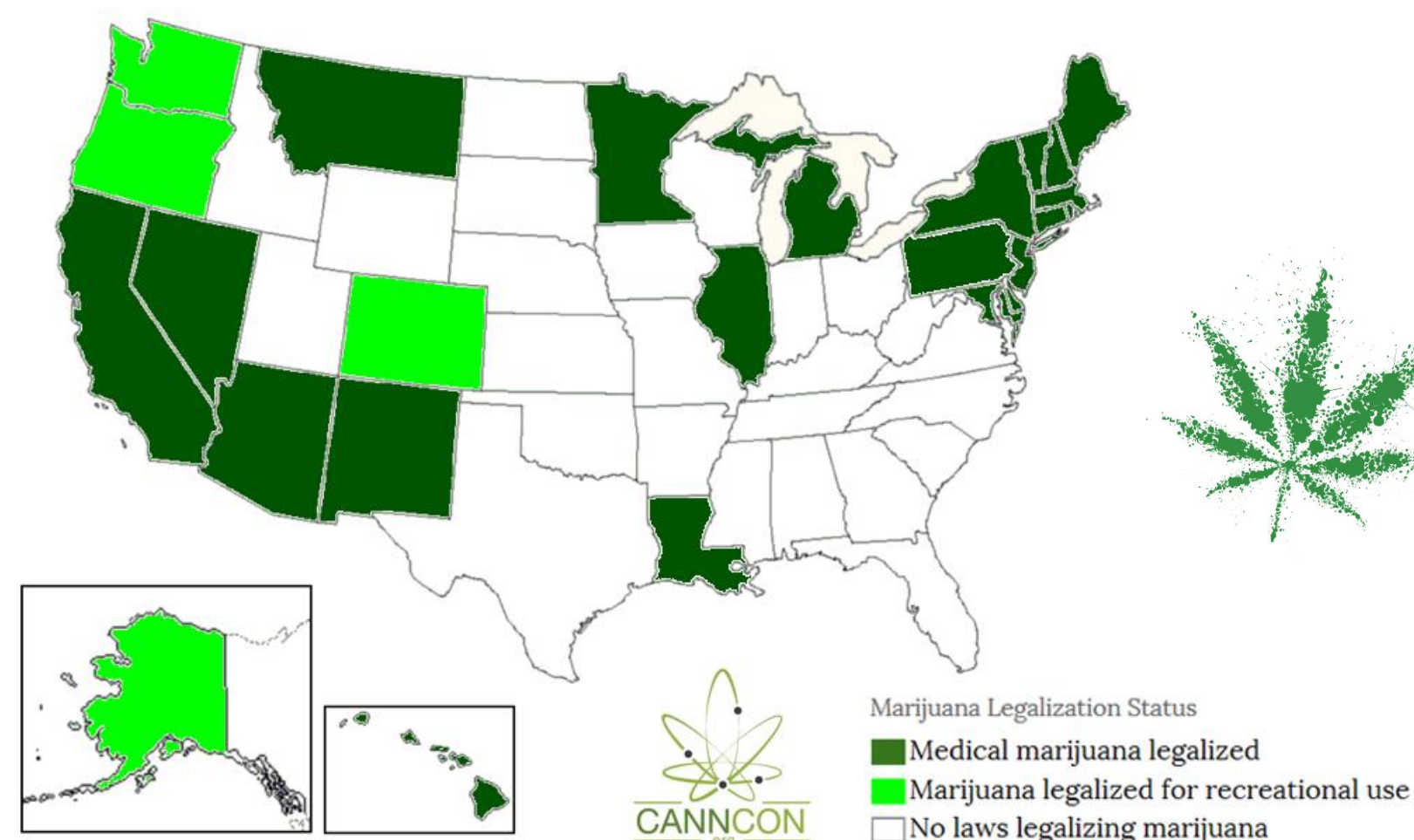
Rachel Lieberman, Scott Kuzdzal, Jeff Dahl, Paul Winkler, Dan Davis and Nicole Lock, Shimadzu Scientific Instruments (Columbia, MD, USA)

## Medical Cannabis Testing: Cannabinomics and Contaminomics!

**Medical cannabis** refers to the use of cannabis and its corresponding cannabinoids, as a therapy to treat diseases and alleviate symptoms. Mass spectrometry has emerged as a powerful tool for cannabis QC testing and research, and is particularly useful for the analysis of cannabis contaminants, including pesticides, mycotoxins/aflatoxins, heavy metals and residual solvents.



Medical cannabis dispensaries offer many forms of cannabis products, ranging from dry products and concentrated oils to edibles and beverages. Medical cannabis card holders typically pay less than recreational cannabis users. Cannabis consumers select their own 'cannaceuticals', but websites like Leafly.com have emerged to provide information and assist consumers with purchases.



Twenty-four U.S. states (plus D.C.) have legalized medicinal cannabis. Four states have legalized recreational use. It is estimated that 18 additional states are considering legalizing recreational cannabis. Canada is anticipated to be fully recreationally legal by 2017.

## Cannabis Testing Instruments & Method Overview

**Cannabis samples were obtained and run in Washington State.** Ground and homogenized cannabis was extracted with a modified QuEChERS strategy and dispersive SPE cleanup (see next pane). Approximately 200 pesticide analytes were measured with over 500 MRM transitions per run. Detection was carried out by UHPLC-MS-MS using a Shimadzu Prominence HPLC with LCMS-8050 triple quad MS. Electrospray ionization was used with continuous polarity switching to allow analysis of pesticides in both positive and negative mode during the same run. Matrix matched calibration curves were linear within the quantitation limits established for each pesticide, which was compound dependent, but ranged from as low as 1.5 ng/g at the lower limit to 2000 ng/g at the upper limit.

**"Big 4" heavy metals by ICPMS:** Metals originate from the soil that cannabis is grown in and concentrated in the plants themselves through natural pathways. The samples shown were acid digested and analyzed with corresponding spikes at the regulated limits.

- Pesticides**  
*LC and GC with MS or ECD*
- Terpenes**  
*LC-MS or GC-MS*
- Heavy Metals**  
*ICP, ICP-MS*
- Residual Solvents**  
*GC or GC-MS*
- Moisture content**  
*Moisture balances*
- Potency**  
*LC or GC (also with MS detection)*
- Micro-organisms**  
*Petri plates or qPCR*



LCMS-8050 Triple Quad



GCMS-QP2020



ICPMS-2030

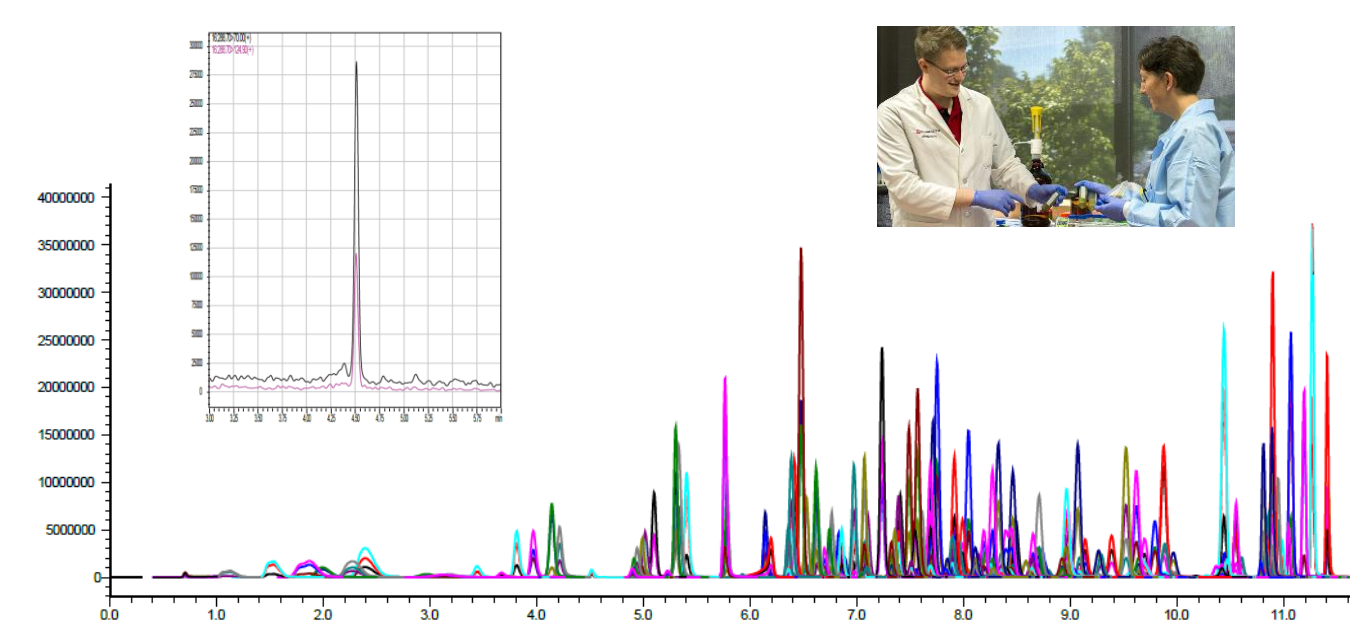
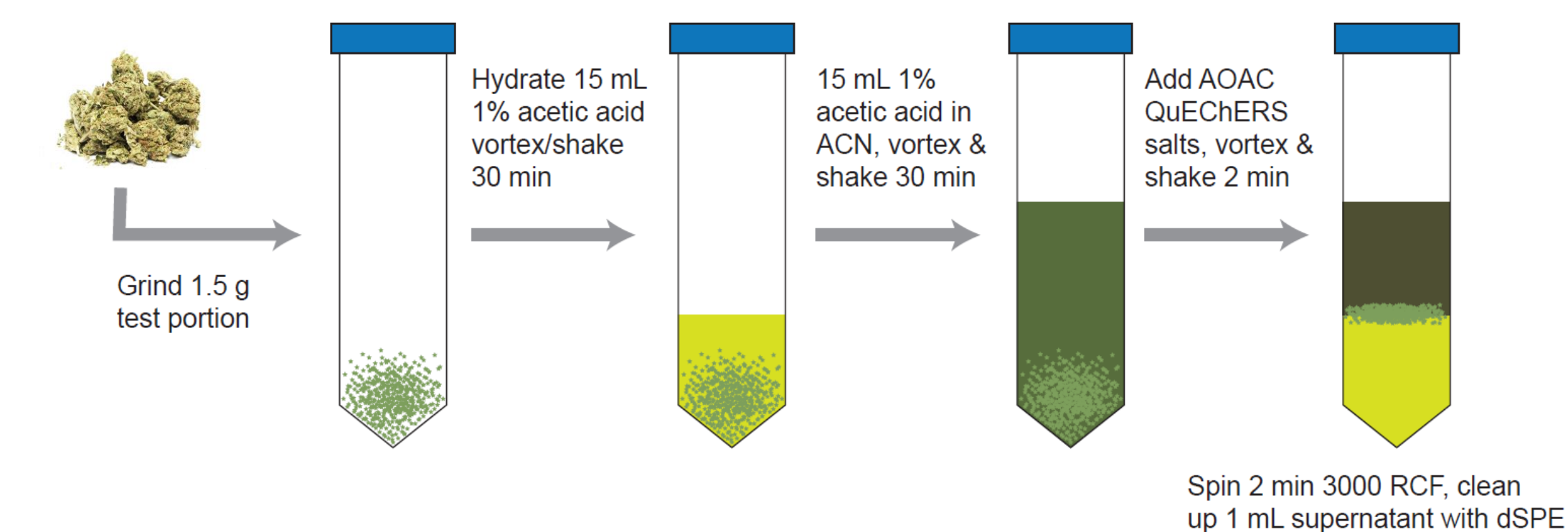


## Mass Spectrometry Applications in Cannabis Testing Laboratories

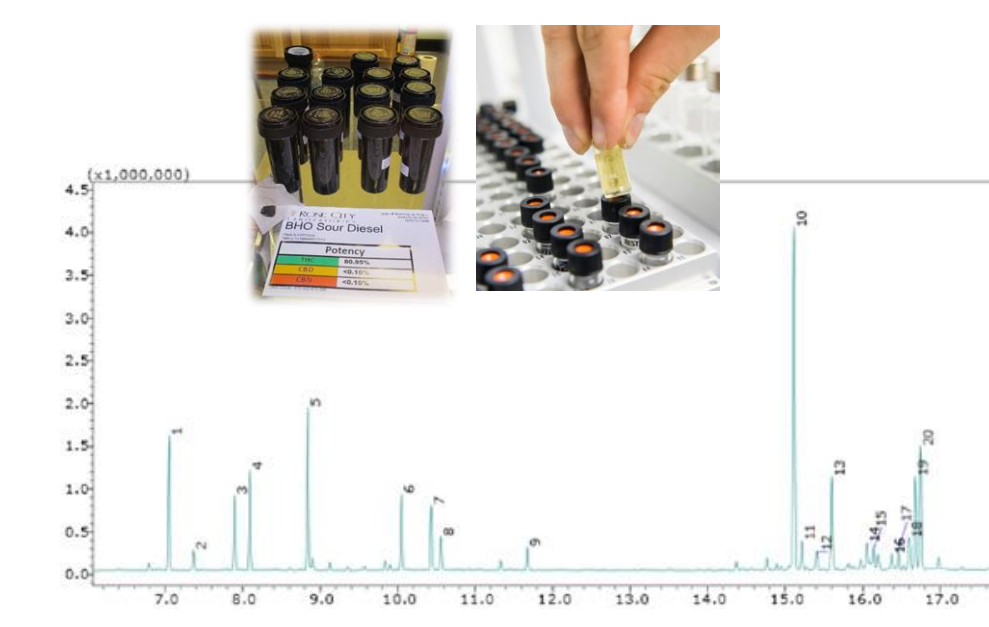
**Mass spectrometry** is used in cannabis testing labs to screen for (A) pesticides by GCMS and LCMS, (B) terpenes by GCMS (and GC), (C) residual solvents left over from extractions by GCMS (and GC) and (D) heavy metals by ICPMS. It is important to test for a wide variety of pesticides employed during cannabis cultivation, including organophosphates, carbamates, pyrethroids and avermectins.

The QuEChERS ("Quick, Easy, Cheap, Effective, Rugged and Safe") method has been readily accepted by many pesticide residue analysts. A modified version of this method was employed for cannabis dry product analyses (see workflow to the right).

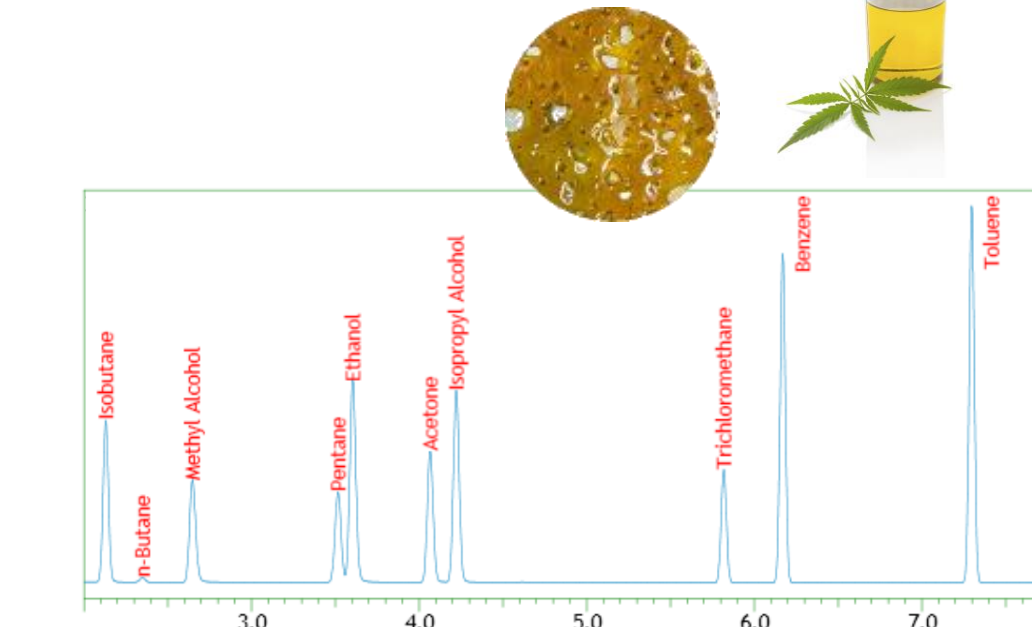
The data below represents typical cannabis testing mass spectrometry results. HPLC is the most commonly used method for potency (cannabinoids), but LCMS can also be used for low-level cannabinoid quantitation (not shown). LCMS can also be used for mycotoxins/aflatoxins analyses.



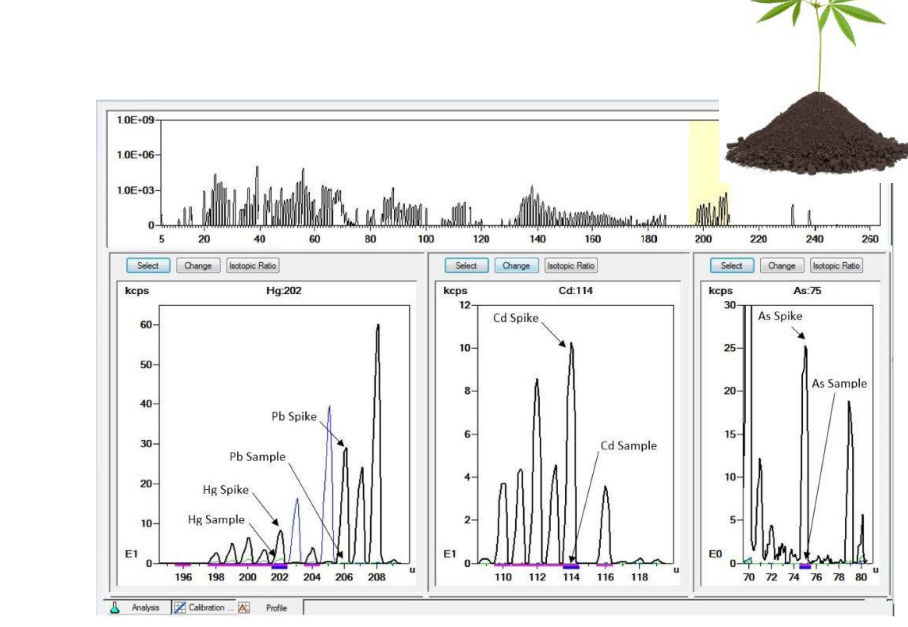
A: High-sensitivity LC-MS/MS analysis of 211 pesticides in cannabis dry product in less than 12 minutes using a Shimadzu LCMS-8050 triple quadrupole mass spectrometer (insert shows 10 ppb myclobutanil pesticide by GCMS).



B: Terpenes in Butane Hash Oil (BHO) by GCMS. Residual solvents are dangerous to all cannabis oil consumers, but pose even greater risk to immunocompromised medical cannabis patients.



C: GCMS with headspace analysis of 10 uL of 1,000 ug/mL of residual solvent standards.



D: Heavy metals by ICPMS. Metals originate from the soil that cannabis is grown in.

## Summary

**Mass spectrometry has many application in cannabis testing labs, from contamination testing (pesticides, residual solvents and heavy metals) to cannabinoid quantitation and terpene profiling.** Ultra-fast mass spectrometry enables simultaneous quantitation of hundreds of pesticides by LC-MS/MS with exceptionally fast cycle times. Five samples obtained at retail establishments contained no detectable pesticide residues, whereas pesticides were identified in seven samples obtained from individual growers known to have used pesticides.

For more information, please visit exhibit booth #1229, [www.GrowYourLab.com](http://www.GrowYourLab.com) or attend the **Cannabis Science Conference** in Portland, Oregon, October 4-6, 2016 ([www.CannabisScienceConference.com](http://www.CannabisScienceConference.com)).

