



Cannabis Potency Testing: Method Development and Cost Considerations

Overview of key method optimization parameters and a featured low-cost methanol method.

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Introduction

Cannabinoid testing is conducted for a variety of reasons, but always to identify and quantitate various cannabinoids in a source tissue or sample, such as tinctures, essential oils, or foods. This application note discusses common parameters of potency testing that can be problematic to method robustness, and presents a method that addresses these while offering cost-savings over most HPLC methods currently employed in testing laboratories.

Method Requirements

Most current cannabinoid analysis methods for routine testing are by reversed-phase chromatography (RPC) with UV detection, and as such require chromatographic separation of the analytes. As the number of analytes needed to be identified and quantified increases, greater selectivity is required of a method. This often involves fine tuning of method parameters that can include column chemistry, pH, buffer strength, temperature, and composition of organic modifier.

Mobile Phase pH

At least two parameters that can be problematic are pH and temperature. Fundamental good practice for RPC, dictates that the pH of a mobile phase should be well-removed from the pKa of the analytes. This is because if the pH is too close to the analyte pKa, there can be large shifts in the retention of the analyte with only a small change in pH. If the mobile phase isn't buffered well, then there can be very significant local pH shifts within the migrating analyte band. Therefore mobile phase pH should be at least 1 pH unit removed from the closest analyte pKa. In the case of cannabinoids, the analyte pKas are generally between pH 3.5 and 4.

Unfortunately, this is also the approximate pH of dilute formic acid/ammonium formate mobile phases commonly employed for cannabinoid analysis. This is however, ironic, for "good" reason: that is, it is at this pH that critical pair resolutions are observed, despite efforts at method development to keep the pH substantially lower or higher, in order to better control the state of ionization of the analytes. Nevertheless it remains, that in terms of good RPC practice for development of robust methods, this is clearly not ideal.

Column Temperature

It's not uncommon to see optimized methods that indicate temperatures of 30 °C or less. There's nothing inherently problematic with that if the column oven has an integrated cooling unit. Many HPLC column ovens, especially lower-cost units, are configured only with a heating element. Therefore any attempts to control temperature at or near room temperature are problematic. When temperature control at or near such values are critical for resolution, users will often be frustrated with too much retention variation if the ovens aren't equipped with a cooling unit and thus cannot maintain a constant temperature.

Organic Modifier

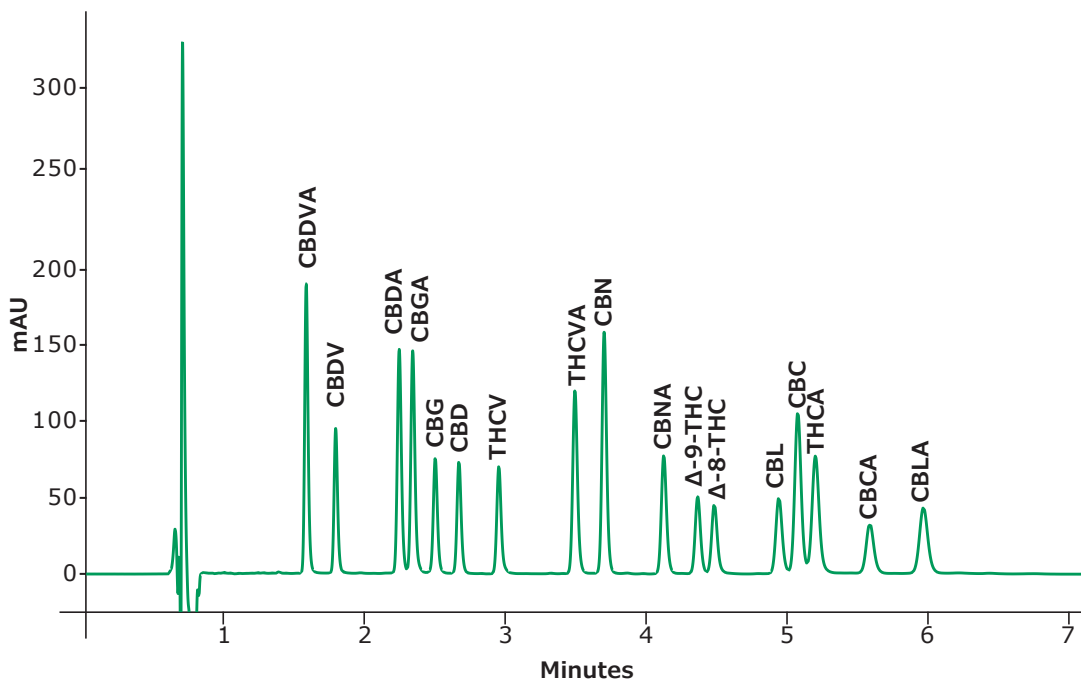
Most often, solutions for RPC resolution of multiple cannabinoids employ acetonitrile as the organic modifier. This is simply because it has permitted quicker and easier solutions for resolution of all sample components. However, the one downfall with acetonitrile, compared to the other common RPC modifier methanol, is cost. Acetonitrile can cost 3 times as much or more.

Case Study – Low Cost Methanol Method

Herein we present an alternate method for analysis of up to 17 cannabinoids that has the following attributes:

- Mobile phase pH is adequately removed from the analyte pKas (the pH of mobile phase A is ~2.6).
- A higher column temperature is used that can be readily controlled by lower-cost heating-only column ovens
- The organic modifier is methanol, thus potentially lowering costs considerably
- The associated backpressures are such that the method doesn't require use of a UHPLC.

Figure 1. Chromatogram of a typical acetonitrile-based gradient method for potency testing.



Method Conditions

Column: Ascentis Express C18, 2.7 μm, 150 x 3 mm (53816-U)

Mobile Phase A: 5 mM Ammonium Formate + 0.1% Formic acid in water

Mobile Phase B: 0.1% Formic acid in acetonitrile

Flow: 0.4 mL/min

Gradient: 75% B to 90% B in 2 min, hold at 90% B 5 min

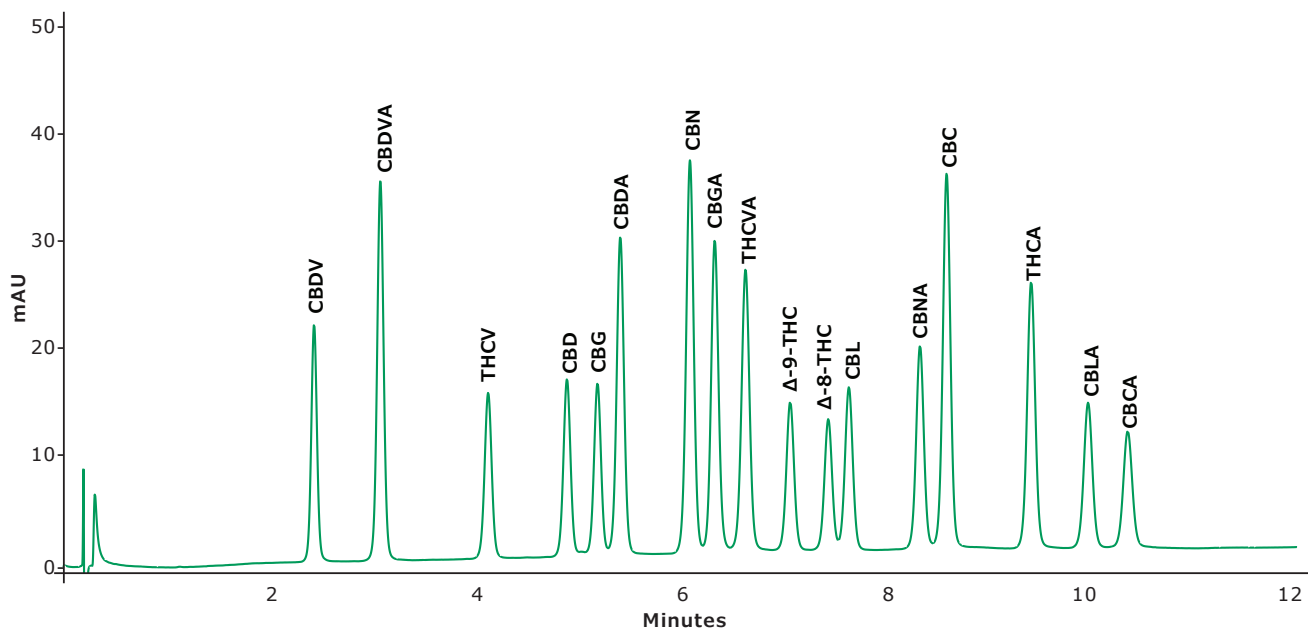
Injection: 3 μL, 25 μg/mL

Column Temp.: 25 °C

Detection: UV, 228 nm

Max Pressure: 530 bar (7690 psi)

Figure 2. Chromatogram of low-cost methanol-based gradient method for potency testing.



Method Conditions

Column:	Ascentis Express C8, 2.7 μm, 50 x 2.1 mm (53831-U)
Mobile Phase A:	0.1% Formic acid in water
Mobile Phase B:	0.06% Formic acid in methanol
Flow:	0.6 mL/min
Gradient:	60% to 75% B in 8 min; hold at 75% B for 4 min
Injection:	0.5 μL, 25 mg/L
Column Temp.:	45 °C
Detection:	UV, 228 nm
Max Pressure:	270 bar (3920 psi).


Table 1. Example of Calculations for Solvent Consumption and Cost Per Injection

Method	Organic	mL	¢/mL	¢
Gradient	ACN	6.14	10.25	62.94
Gradient MeOH	MeOH	5.31	3.58	19.01

Discussion

In **Figure 1** you see a common method based on use of acetonitrile as the organic modifier. **Figure 2** is the alternate methanol-based method. While the runtime of the latter is increased 70%, it's still a very reasonable length, under 12 min. Even with the added length, the cost calculations (**Table 1**) of the volume of organic solvent consumed is about 3-fold less. As long as the throughput is sufficient, this represents a cost-savings that can be readily realized. For either method, further gains in resolution can be attained by using the smaller particle 2 μm Ascentis Express columns.

Featured and Related Products

Product Description	Cat. No.
HPLC Columns	
 Ascentis® Express C8 column, 2.7 µm, 50 x 2.1 mm I.D.	53831-U
Ascentis Express C18, 2.7 µm, 150 x 3 mm I.D.	53816-U
Ascentis® Express C8, 2.7 µm guard cartridge 5 mm x 2.1 mm, pkg of 3 ea	53509-U
Ascentis® Express C18, 2.7 µm guard cartridge 5 mm x 3 mm, pkg of 3 ea	53504-U
Ascentis® Express Guard Cartridge Holder	53500-U
Accessories	
 Certified Vial Kit, Low Adsorption (LA), 2 mL, pk of 100 volume 2 mL, amber glass vial (with marking spot), natural PTFE/silicone septa, thread 9 mm	29653-U
Certified Reference Materials	
Cannabinoid Mixture (Acids) 6 Component including CBCA, CBDVA, CBDA, CBGA, THCVA, and THCA-A in 1% DIPEA and 0.05% Ascorbic acid in Acetonitrile, each analyte at 500µg/mL, certified reference material, ampule of 1mL, Cerilliant®	C-218
Cannabinoid Mixture (Neutrals) 8 Component including CBG, Cannabinol, CBD, CBDV, (-)-delta8-THC, (-)-delta9-THC, and THCv in Acetonitrile, each analyte at 500µg/mL, certified reference material, ampule of 1mL, Cerilliant®	C-219
Cannabidivarinic Acid (CBDVA) solution 1.0 mg/mL in acetonitrile, certified reference material, ampule of 1 mL, Cerilliant®	C-152
1.0 mg/mL in methanol, ampule of 1 mL, certified reference material, Cerilliant®	C-140
Cannabidiolic acid (CBDA), 1.0 mg/mL in acetonitrile, ampule of 1 mL, certified reference material, Cerilliant®	C-144
Cannabigerolic acid (CBGA), 1.0 mg/mL in acetonitrile, ampule of 1 mL, certified reference material, Cerilliant®	C-142
Cannabigerol (CBG), 1.0 mg/mL in methanol, ampule of 1 mL, certified reference material, Cerilliant®	C-141
 Cannabidiol solution, 1.0 mg/mL in methanol, ampule of 1 mL, certified reference material, Cerilliant®	C-045
Tetrahydrocannabivarin (THCV), 1.0 mg/mL in methanol, ampule of 1 mL, certified reference material, Cerilliant®	T-094
Tetrahydrocannabivarinic acid (THCVA), 1.0 mg/mL in acetonitrile, certified reference material, ampule of 1 mL, Cerilliant®	T-111
Cannabinol (CBN), 1.0 mg/mL in methanol, ampule of 1 mL, certified reference material, Cerilliant®	C-046
Cannabinolic acid (CBNA), 1.0 mg/mL in acetonitrile, certified reference material, ampule of 1 mL, Cerilliant®	C-153
Δ9-tetrahydrocannabinol (Δ9-THC), 1.0 mg/mL in methanol, ampule of 1 mL, certified reference material, Cerilliant®	T-005
Δ8-tetrahydrocannabinol (Δ8-THC), 1.0 mg/mL in methanol, ampule of 1 mL, certified reference material, Cerilliant®	T-032
Cannabicyclol (CBL), 1.0 mg/mL in acetonitrile, certified reference material, ampule of 1 mL, Cerilliant®	C-154
Cannabichromene (CBC), 1.0 mg/mL in methanol, ampule of 1 mL, certified reference material, Cerilliant®	C-143
Δ9-tetrahydrocannabinolic acid (THCA), 1.0 mg/mL in acetonitrile, ampule of 1 mL, certified reference material, Cerilliant®	T-093
Cannabichromenic acid (CBCA), 1.0 mg/mL in acetonitrile, certified reference material, ampule of 1 mL, Cerilliant®	C-150
Cannabicyclic acid (CBLA), 0.5 mg/mL in acetonitrile, certified reference material, ampule of 1 mL, Cerilliant®	C-171
Water, Solvents and Chemicals	
 Methanol, UHPLC grade, Sigma Aldrich	900688
Formic acid 98% - 100%, for LC-MS, LiChropur™	5330020050
Acetonitrile with 0.1 % (v/v) formic acid for UHPLC, Sigma Aldrich	900686
Ammonium formate ≥99.0%, for LC-MS, LiChropur™	70221
Ultrapure water from Milli-Q® system or bottled water	Milli-Q® IQ 7005 or 101262

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