

CANNABIS PROFICIENCY TESTING

 The New Industry Imperative for Quality & Consumer Safety



letter from the PUBLISHER

AS THE U.S. LEGAL CANNABIS market continues to mature, establishing and adopting standards and practices are becoming increasingly challenging in their mandate to better facilitate manufacturing, measurement, communication, and commerce. Understanding the current testing environment, any gaps and challenges, and future opportunities has become imminently important to make better investment, operative, and regulatory decisions in support of a healthy, transparent, and effective legal cannabis industry in the U.S. and abroad.

Pending federal reform, the U.S. legal cannabis industry has no federal regulatory body to guide it, but with some form of legalization (i.e., medicinal or adult-use) already in play among more than 40 states, cannabis has been establishing itself as a major consumer packaged goods investment allocation. As consumers look to be reassured about their product choices, accreditation bodies have attempted to codify customers' requirements while sensitivities are also becoming increasingly stringent; the converging market forces are creating an immediate need for correspondingly more sensitive proficiency testing.

New Frontier Data, in partnership with Emerald Scientific, proudly presents this latest industry release, **Cannabis Proficiency Testing: The New Industry Imperative for Quality and Consumer Safety**. The new study analyzes quality and safety testing across the cannabis industry, concluding that proficiency testing, the mainstay for compliance and quality assurance in the legal cannabis industry, represents

a top priority and major share of the global cannabis testing service industry given that it is projected to exceed \$41 billion in sales by 2025.

There are approximately 250 licensed laboratories operating in the U.S. to fulfill state testing requirements regulating high-THC cannabis supply. Testing for potency and contaminants is essentially important for hemp cultivators and CBD producers navigating dynamic legalities, and it affords manufacturers and retailers some opportunity to elevate their brands and credibility, particularly in terms of consumer safety.

Amid disruptions and reverberations from the COVID-19 pandemic, a premium is being placed on proficiency testing for cannabis. Demand for quality and transparency in legal markets will only increase as legalization spreads nationwide — and as legitimate products will be able to prove, differentiate, and eventually best leverage themselves to potential business partners, customers, and international markets alike on the demonstrated strength of their testing.

As with all our reports available through New Frontier Data's online intelligence portal Equio™, we trust that readers will benefit from this fact-based assessment, our unbiased insights, and the actionable intelligence provided to continue to succeed in the global legal cannabis arena.

New Frontier Data's mission is to elevate the discussion around the legal cannabis industry globally by providing unbiased, vetted information intended for educating stakeholders to make informed decisions. We provide individuals and organizations operating, researching, or investing amid the cannabis industry with unparalleled access to actionable industry intelligence and insights, helping each to leverage the power of knowledge to succeed in a fast-paced and dynamic market.

Please do enjoy our newest report as you shape your strategy and devise your action plan within the cannabis industry!



Giadha A. DeCarcner
Founder and CEO,
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ABOUT

New Frontier Data



NEW FRONTIER DATA is an independent, technology-driven analytics company specializing in the global cannabis industry. It offers vetted data, actionable business intelligence and risk management solutions for investors, operators, researchers, and policy makers. New Frontier Data's reports and data have been cited in more than 85 countries worldwide to inform industry leaders. Founded in 2014, New Frontier Data is headquartered in Washington, D.C., with additional offices in Denver, CO, and London, U.K.

New Frontier Data does not take a position on the merits of cannabis legalization. Rather, its mission and mandate are to inform cannabis-related policy and business decisions through rigorous, issue-neutral, and comprehensive analysis of the legal cannabis industry worldwide.

For more information about New Frontier Data, please visit: NewFrontierData.com.

Mission

New Frontier Data's mission is to elevate the discussion around the legal cannabis industry worldwide by providing unbiased and vetted information intended to educate stakeholders to make informed decisions.

Core Values

- Honesty
- Respect
- Understanding

Vision

Be the Global Big Data & Intelligence Authority for the Cannabis Industry.

Commitment to Our Clients

The trusted one-stop shop for actionable cannabis intelligence, New Frontier Data provides individuals and organizations operating, researching, or investing in the cannabis industry with unparalleled access to actionable industry intelligence and insight, helping them leverage the power of big data to succeed in a fast-paced and dynamic market.

We are committed to the highest standards and most rigorous protocols in data collection, analysis, and reporting, protecting all IP and sources, as we continue to improve transparency into the global cannabis industry.



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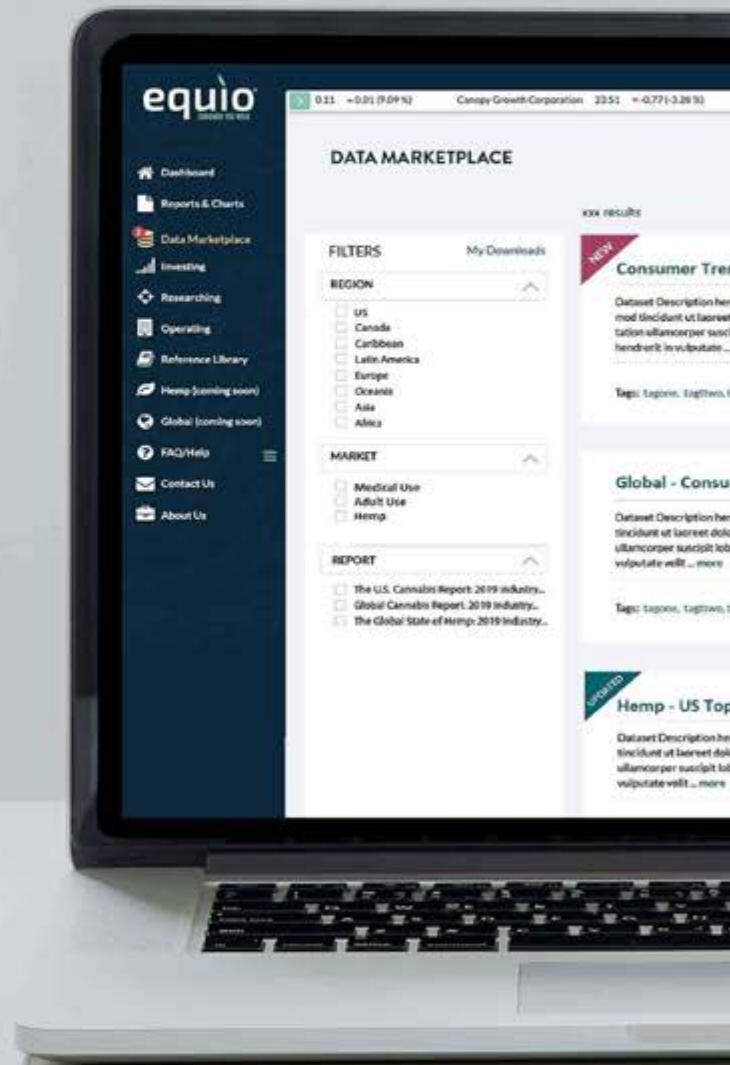
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Cannabis Proficiency Testing

The New Industry Imperative for Quality and Consumer Safety

CANNABIS TESTING represents a fundamental mainstay for the legal cannabis economy. In the United States, about 250 laboratories are licensed to fulfill state testing requirements regulating the nation's high-THC cannabis supply. Testing for potency and contaminants is essentially important for hemp cultivators and CBD producers navigating dynamic legalities. Whereas less than 10 years ago cannabis quality-assurance safeguards were generally limited to THC potency tests using techniques appropriate only for analyzing a limited number of cannabinoids, today's testing labs have ballooned in numbers and scope to become multimillion-dollar operations to screen pesticides, heavy metals, terpenes, and a host of other analytes.

Beyond compliance obligations, cannabis brands and product manufacturers place premiums on testing because their consumers increasingly and deeply care about quality metrics. In surveys, cannabis users specifically cite "testing results" and "what ingredients are in my cannabis" as top influences when making THC and CBD purchasing decisions. Assuaging consumer safety concerns with verified test results makes strategic sense for many consumer brands.

Increasingly, cannabis quality-assurance testing facilities are adopting International Organization for Standardization (ISO) testing standards like ISO 17025 accreditation, and participating in cannabis-specific proficiency testing to meet business and compliance goals. Brands and product manufacturers who choose such testing facilities can benefit by promoting consumer safety advantages which testing through labs confirms about their products.



Beyond
compliance...
brands and
manufacturers
care about testing
because their
customers care.





Accreditation & Proficiency Testing

The prioritization of consumer safety tests for pesticides, mold, salmonella and E. coli — alongside traditional potency tests like THC and cannabinoid content — has forced labs to employ more sophisticated means of analysis and record-keeping. As seen among other industries' testing facilities, cannabis labs are implementing standard operating procedures (SOPs) and best practices to pass muster with regulators and consumers.

The ISO 17025 accreditation is one important standard gaining traction in cannabis. ISO 17025 accreditation ensures that a testing lab meets certain quality standards, with the stated goal of enabling laboratories "to demonstrate that they operate competently and generate valid results, thereby promoting confidence in their work both nationally and around the world". The accreditation serves as the main standard for testing and calibration labs serving each the food, pharmaceutical, petrochemical, and environmental industries. Many states are moving toward requiring laboratories to earn ISO accreditation for cannabis-testing licensure.

ISO 17025 accreditation requires each testing lab to pass a proficiency test (PT) for the given area(s) of analytics within the scope for which they applied. PTs may be required for cannabis-testing licensure even in states where ISO 17025 accreditation is not mandated. Typically, a PT is manufactured by an ISO 17043-accredited company. The PT

manufacturer (or a third-party PT provider) will send the PT containing a contaminated matrix to the lab which is enrolled in the test. The PT provider, knowing the exact makeup of the matrix, can then score the accuracy of the lab. PTs are available in many forms, and may be offered throughout the year. Some states require that a specific number of PTs be performed in a given year.

An inter-laboratory comparison/proficiency test (ILC/PT) further allows a testing lab which has taken the same PT as another to compare results. ILC/PTs are deemed invaluable for identifying areas for improvement, whether on an individual basis or for the industry at large. Many ILC/PT results are anonymized, affording industry stakeholders unbiased looks into performance.

Beyond accreditation and compliance, ILC/PTs are important for validity and product development. Proficiency testing serves to alert the rest of the industry (and ultimately consumers) that analytical labs in the cannabis space are sophisticated and accurate. Proficiency testing allows labs to constantly update and improve their processes, and to provide feedback to the industry. For example, ILC/PTs might show that labs are having difficulties with accurate detection of the presence or amount of a given analyte (e.g., a specific pesticide or terpene). ILC/PT providers can provide such feedback to governmental agencies which regulate the testing requirements, potentially triggering adjustments to passing thresholds or the addition of new tests. Given relatively clumsy rollouts of cannabis testing regulations in most states (along with a lack of nationally unified regulatory policy), ILC/PTs have proven critical to helping regulators standardize the types of tests and their according pass/fail sensitivities. Ultimately, the dynamic helps forward product manufacturing and GMP objectives.



The Emerald Test™

The Emerald Test is the cannabis industry's most widely used ILC/PT.

During last fall's period for the Emerald Test, 123 cannabis and/or hemp testing facilities from 30 states and 9 countries were enrolled: The Fall 2020 Emerald Test comprising 25 PTs tested for 183 different analytes.

Recorded results from different testing periods are available for review ([2014-Fall 2020, inclusive](#)). Labs interested in participating can register through [biannual open enrollment periods](#).



THE EMERALD TEST Fall 2020 Overview

Potency in Solution 8 Analytes 90% Pass Rate <i>0 Analytes pass at all labs</i>	Pesticides in Hemp Flower 67 Analytes 96% Pass Rate <i>44 Analytes (66%) pass at all labs</i>	Potency in Hemp Oil 6 Analytes 90%+ Pass Rate <i>0 Analytes pass at all labs</i>	Potency in Hemp Bud 7 Analytes 86% Pass Rate <i>0 Analytes pass at all labs</i>	Potency in Gummy 5 Analytes 95% Pass Rate <i>3 Analytes (60%) pass at all labs</i>
Potency in Beverage 6 Analytes 100% Pass Rate <i>6 Analytes (100%) pass at all labs</i>	Potency in Hard Candy 5 Analytes 97% Pass Rate <i>4 Analytes / 80% pass at all labs</i>	CBD in Topical Cream 1 Analyte 75% Pass Rate <i>0 Analytes pass at all labs</i>	Residual Solvents in Hemp Oil 24 Analytes 85% Pass Rate <i>6 Analytes (25%) pass at all labs</i>	Heavy Metals in Hemp Oil 4 Analytes 84% Pass Rate <i>0 Analytes pass at all labs</i>
Heavy Metals in Hemp Bud 4 Analytes 81% Pass Rate <i>0 Analytes pass at all labs</i>	Terpenes in Hemp Bud 10 Analytes 66% Pass Rate <i>0 Analytes pass at all labs</i>	Mycotoxins in Hemp 6 Analytes 88% Pass Rate <i>0 Analytes pass at all labs</i>	(+/-)-Alpha-Tocopherol Acetate 1 Analyte 100% Pass Rate <i>1 Analyte (100%) pass at all labs</i>	Foreign Materials in Hemp 1 Analyte 96% Pass Rate <i>0 Analytes pass at all labs</i>
Water Activity (Humidity) in Hemp Bud 1 Analyte 100% Pass Rate <i>1 Analyte (100%) pass at all labs</i>	Microbial Panel 1: Hemp 5 Analytes 93% Pass Rate <i>1 Analyte (20%) pass at all labs</i>	Microbial Panel 2: Salmonella in Hemp 1 Analyte 97% Pass Rate <i>0 Analytes pass at all labs</i>	Microbial Panel 3: STEC in Hemp 7 Analytes 88% Pass Rate <i>5 Analytes (71%) pass at all labs</i>	Microbial Panel 4: Aspergillus Molds in Hemp 5 Analytes 79% Pass Rate <i>0 Analytes pass at all labs</i>
Microbial Panel 5: Salmonella in Chocolate 1 Analyte 100% Pass Rate <i>1 Analyte (100%) pass at all labs</i>	Microbial Panel 6: STEC in Chocolate 1 Analyte 94% Pass Rate <i>0 Analytes pass at all labs</i>	Microbial Panel 7: Salmonella in Hemp Oil 1 Analyte 100% Pass Rate <i>1 Analyte (100%) pass at all labs</i>	Microbial Panel 8: STEC in Hemp Oil 1 Analyte 80% Pass Rate <i>0 Analytes pass at all labs</i>	Microbial Panel 9: Aspergillus Molds in Hemp Oil 5 Analytes 88% Pass Rate <i>1 Analyte (20%) pass at all labs</i>



A Data Dive Into the Results

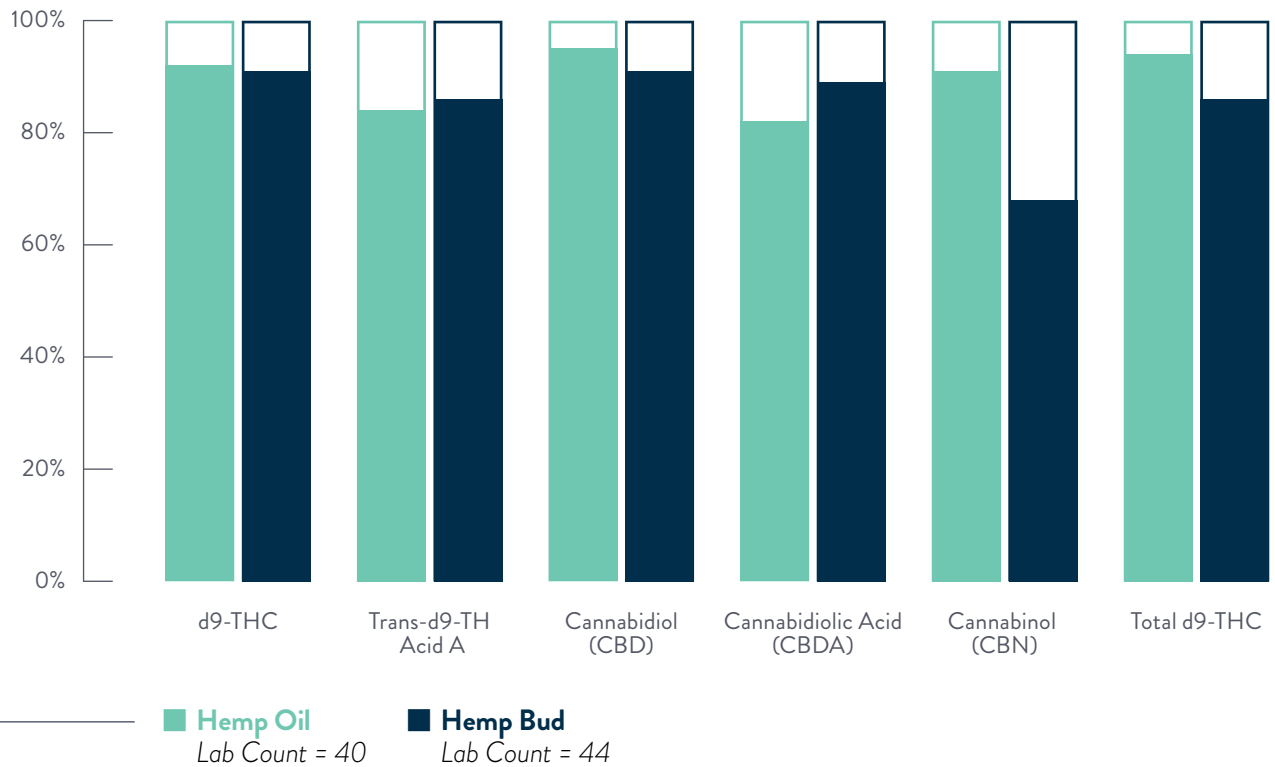
A data study of Emerald Test results illustrates how labs are performing with increased sophistication and accuracy, indicating that cannabis testing facilities are performing increasingly accurate work. More than 4,000 data fields were analyzed for the Fall 2020 test, which found a combined pass rate of 90%+.

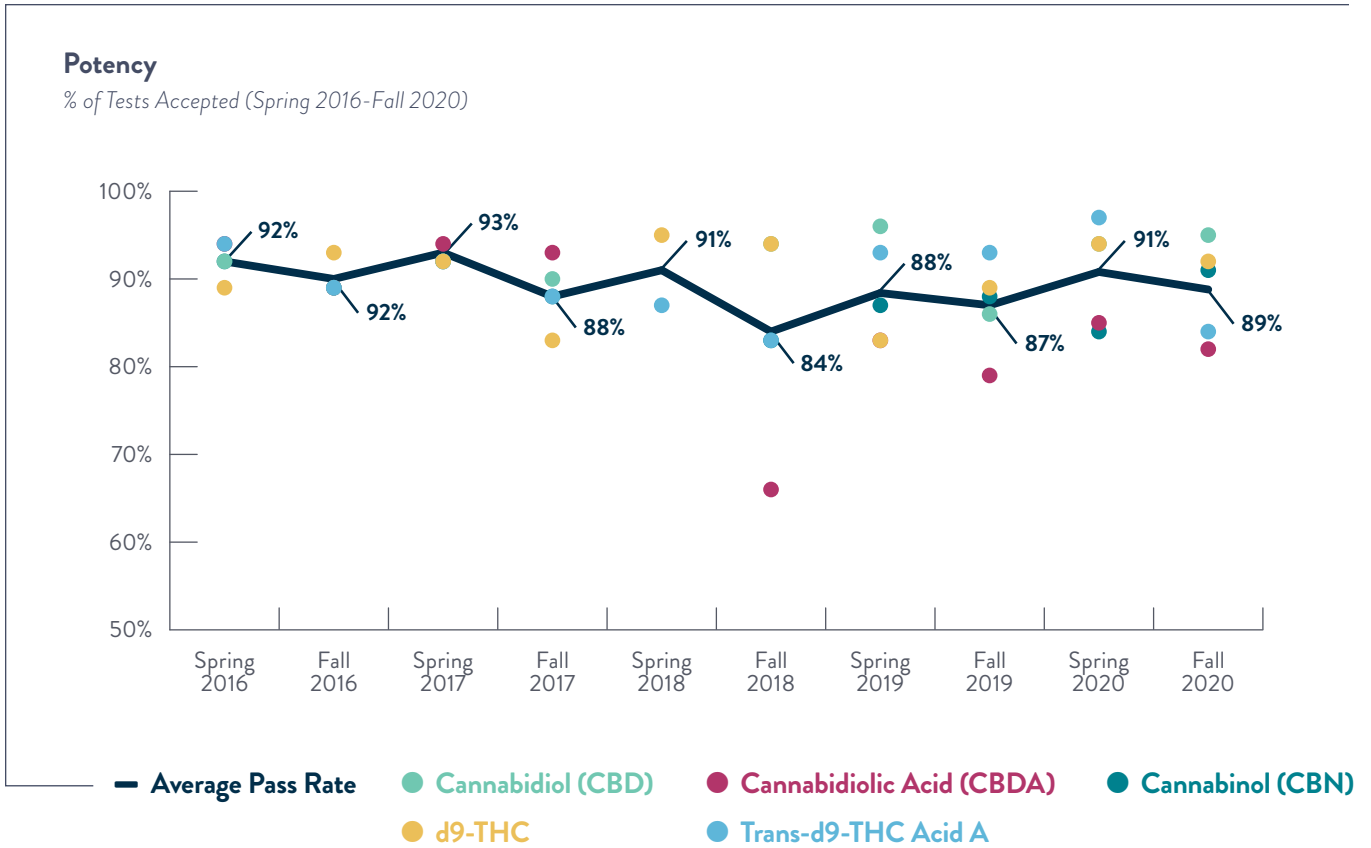
POTENCY

Potency in hemp bud and oil, respectively, are the most popular among the Emerald Test™ PTs. The tests are designed to measure the potency of the respective cannabinoids THC, THCA, CBD, CBDA, and CBN. Pass rates during the Fall 2020 test ranged from a high of 95% for CBD in hemp oil, to a low of 68% for CBN in hemp bud.

Potency: Hemp Bud/Oil

% of Tests Passed (Fall 2020)



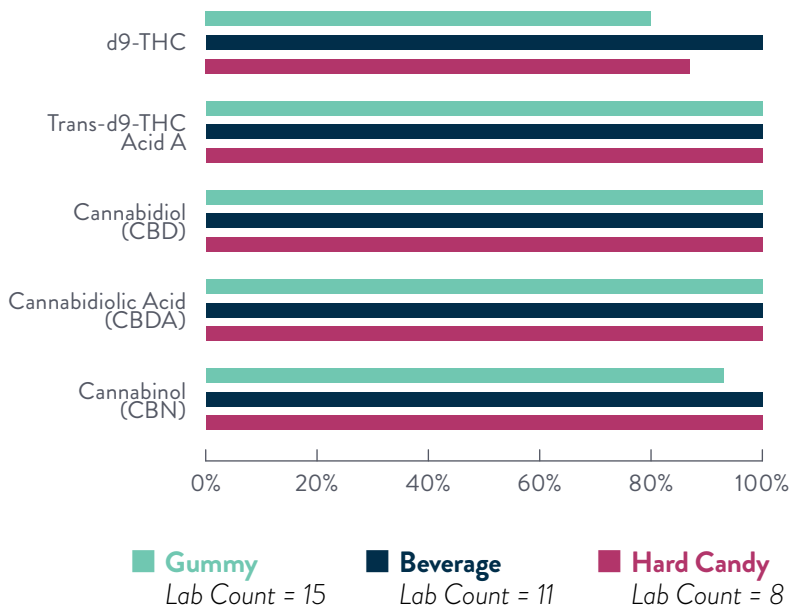


Potency results have shown consistency over time: The average pass-rate is 89% over the history of the test, dropping below 85% but once (i.e., Fall 2018).

Labs have also demonstrated exceptional results across other matrices, including gummies, beverages, and hard candy. The combined pass rate was 97%, albeit fewer labs took the test.

Potency: Gummy/Beverage/Hard Candy

% of Tests Accepted (Fall 2020)



INCREASING SOPHISTICATION

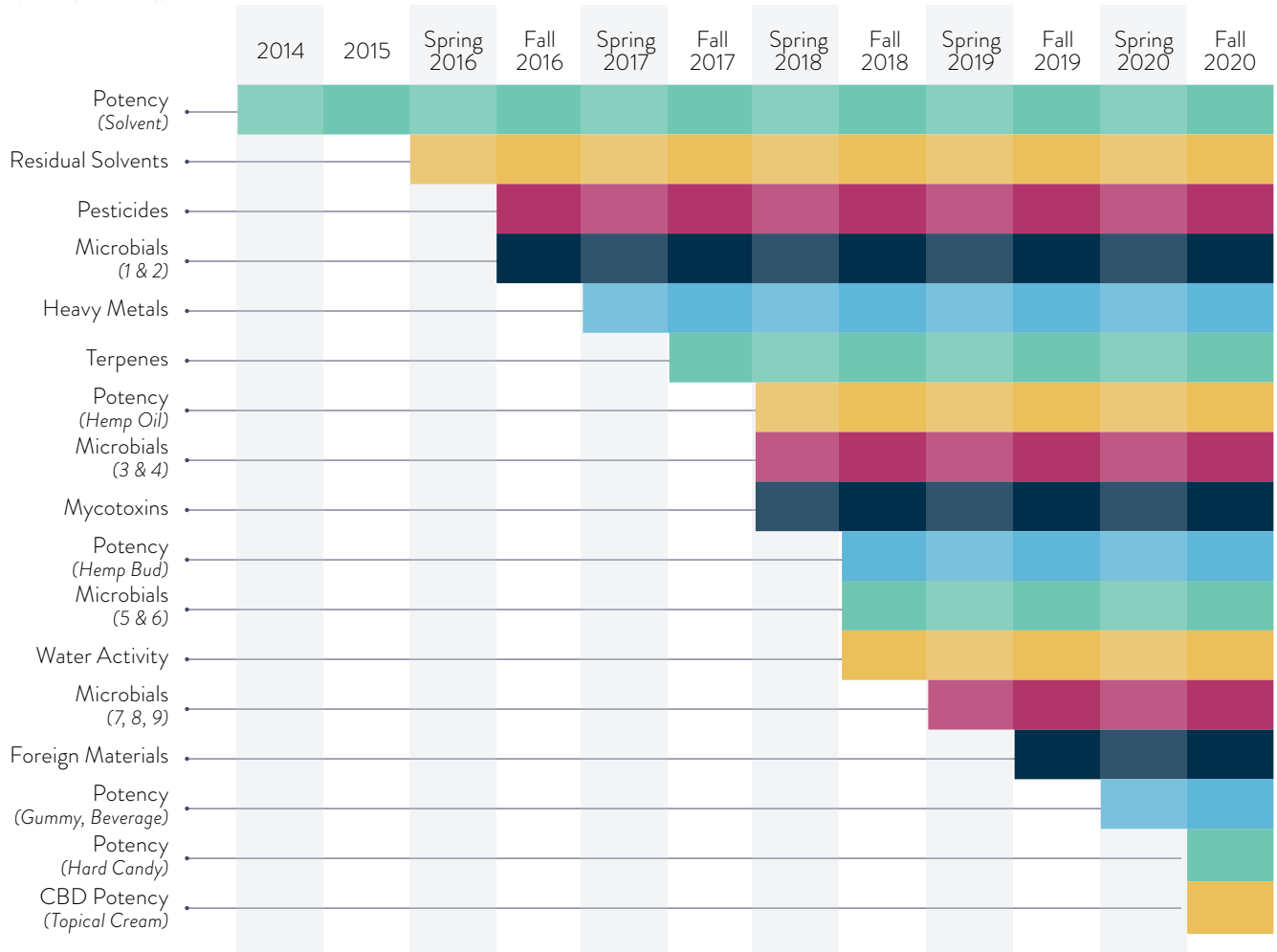
In its latest iteration, the Emerald Test offers 25 proficiency tests, up from a single proficiency test for potency in 2014 and 2015. Testing is now common for residual solvents, molds, heavy metals, pesticides, terpenes and microbials. That various matrices including gummies, beverages, and hard candy are also available for testing speaks to the sophistication and capabilities of the science and analysis which have entered the cannabis industry.

There is reason to believe that the expansion of Emerald Test ILC/PT offerings may be serving as a catalyst for new technology and innovative practices. For example, there is a shift from gas chromatography (GC) to high-performance liquid chromatography (HPLC) in order to quantify the acid cannabinoids more easily than through derivatization.

The level of precision needed to pass an Emerald Test PT has also increased over time. As the accreditation bodies have codified their requirements, sensitivities have become increasingly stringent, creating a need for correspondingly more sensitive proficiency testing. As the market matures, it is likely that the inaccuracy allowances will likewise become more strict as lab proficiencies increase.

The Emerald Test

Proficiency Tests Offered



IMPROVEMENT OVER TIME

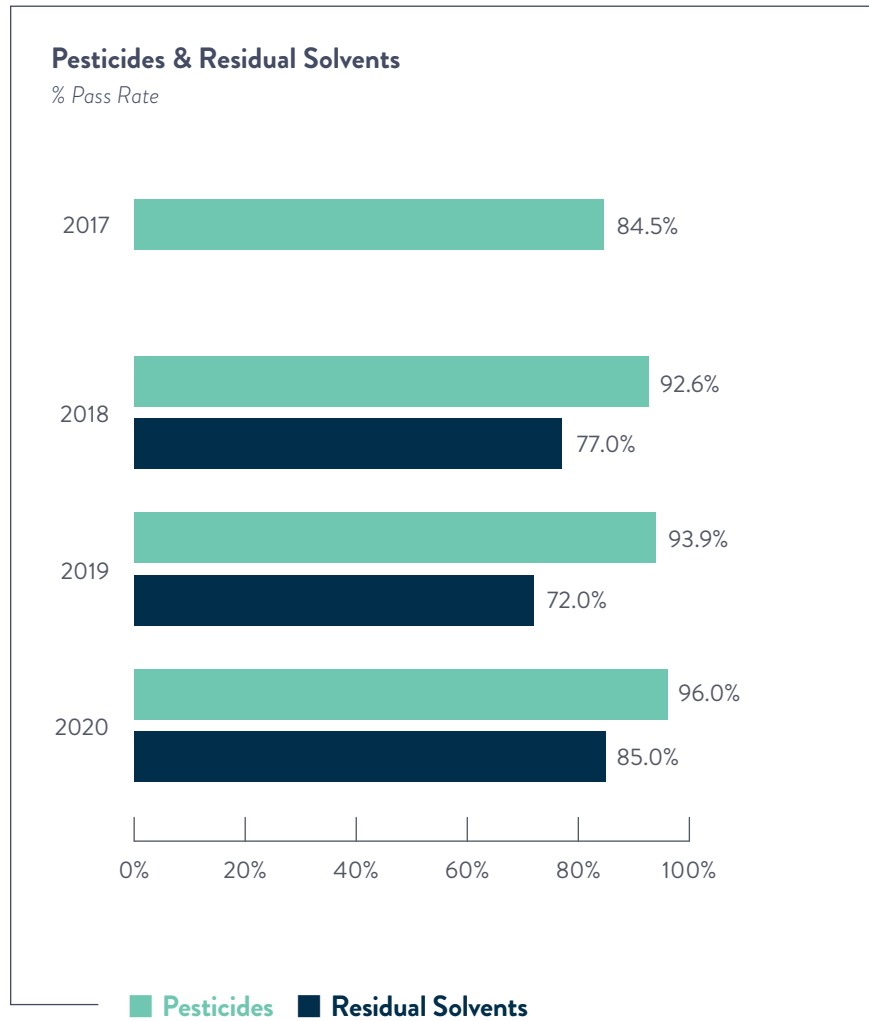
The Emerald Test also shows several areas of improvement: The Fall 2020 Terpenes in Hemp Bud test had a combined pass rate of only 67% across the 345 data points studied, a marginal improvement from a 62% pass rate in Spring 2018. Acceptance criteria remained constant for the terpene PT (at +/- 40% recovery).

Pesticides in Hemp Flower is another area where laboratories have shown improvement over time, with pass rates improving from 85% to 96% between 2017 and 2020. These have come despite increasing stringency (with 67 analytes tested in 2020, versus 20 in 2017). The Residual Solvents PT also saw an uptick in pass rates (85% in 2020).

THE EMERALD BADGE

Given disparate state standards and consumer preferences for quality products, it would behoove testing facilities to broadcast the caliber of their work. The Emerald Test allows for such quality assurances through its Emerald Badge™. The Emerald Badge is awarded to labs which perform within a specific tolerance in each proficiency test category, with criteria established by the ISO-accredited PT manufacturer with input from the Emerald Test Advisory Panel.

Each lab that earns an Emerald Badge is equipped with a marketing tool to promote its capabilities in comparison to its peers, signaling to consumers (and the cannabis industry at large) that the lab performs accurate work.



Many labs which have embraced the badge program use it in their advertising, lauding how many badges they have respectively earned.

It is worth noting that in the Fall 2020 test — and for the first time — three labs participated in all 25 PTs, and were awarded Emerald Badges for each one. It marks a significant achievement, highlighting the sector's continued maturation and improved performance. Among the 610 PTs entered for review, 511 Emerald Badges were awarded.





Key Insights for the Industry

Many bad actors yet remain in the cannabis testing space, providing false reports whether by choice or in lacking the competency to generate accurate results.

While not rampant, some are advertising results without ever testing the material. That has created a problem of cultivators' and product manufacturers' lab shopping, because simply a 1-3% boost in cannabinoid content can translate into hundreds of thousands of dollars depending on scale, due to the premiums paid for more potent products. Labs have an underhanded incentive to do the same and endear themselves to cultivators for more business, but at the cost of undermining the sector overall at a time when precise dosing is increasingly important for product formulation.

While proficiency testing and accreditation are mechanisms to ensure that labs have sufficient capabilities to perform accurate work, they also create a comparative dynamic allowing accredited labs to define themselves within an increasingly competitive market. As more states legalize, and the volume of products tested in legal markets grows, labs which can differentiate themselves through the accuracy of their testing will be better positioned to attract producers and suppliers seeking consistent, high-quality services.

The impact of COVID-19 reverberated to the cannabis proficiency-testing space. While a record number of 123 laboratories enrolled for the Fall 2020 Emerald Test™ (the 13th-consecutive round that participants have increased), the total number of PT samples scheduled to ship was 623, slightly below the 700 PT samples ordered during the Spring 2020 test.

With the sales of cannabis products in currently legal U.S. states forecast to grow from \$20 billion in 2020 to over \$45 billion in 2025, the lab testing market is positioned for explosive growth within the next few years. The addition of new states (e.g., New York, Pennsylvania, Virginia, and Florida all being on track to pass adult-use measures within the next two years) will only further expand the market opportunities for labs while heightening the competitive environment within the lab market, making accreditation or other differentiation opportunities more attractive.

While minor cannabinoids (e.g., CBG, CBN, THC-V) represent a relatively small proportion of the overall cannabis market, the growing science affirming both their therapeutic value and increasing use in novel consumer products suggests that demand for testing of minor cannabinoids will increase significantly in the coming years. Since minor cannabinoid testing has been an area where lab proficiency is lowest, labs should begin to refine their minor cannabinoid testing protocols to ensure that they are delivering accurate results, and are prepared for the expanding market interest in those compounds.



● Product manufacturers and cultivators are beginning to utilize in-house testing as part of their quality-control and assurance programs. Proficiency testing is an invaluable tool for in-house labs striving to reach the level of accuracy of third-party labs. Many states, however, still require samples to be tested at third-party labs.

● Testing quality and consistency will continue to influence not only domestic production, but also international trade. Producers who can meet quality thresholds (e.g., EU Good Manufacturing Practices) will have more options when it comes to exporting their products, and could accordingly garner competitive advantages as the international cannabis market matures.





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