

Standards for Cannabis Testing Laboratories

Cannabis Safety Institute
December, 2014

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Introduction

Prior to the legalization of recreational Cannabis in Washington and Colorado, a number of Cannabis testing laboratories were already in operation in those and several other states. These laboratories primarily served the market for potency testing of medical marijuana, although they had begun to offer such services as microbiology testing. They were entirely unregulated, and in some states even their legality was unclear. As Washington and Colorado began structuring their legal recreational Cannabis programs, these states included rules requiring safety testing of Cannabis. Oregon added similar rules to its medical marijuana program. In the absence of traditional analytical chemistry laboratories able or willing to test Cannabis, these states have turned to the existing Cannabis testing industry to meet their mandated testing requirements.

In response to this increase in demand, roughly 30 new Cannabis testing laboratories have opened in 2014. Washington and Colorado have introduced programs to inspect and certify these laboratories, but there has been a good deal of confusion over what tests the laboratories should perform and what standards they should be held to. No other state has put an oversight program into place. Oregon recently began to require that all medical Cannabis be tested, yet has failed to address the legality of the laboratories performing this work.

Faced with regulating an entirely new large-scale agricultural product in the absence of any guidance from the United States Department of Agriculture (USDA) and the Food and Drug Administration (FDA), many state regulatory agencies have determined that *some* safety testing is better than no safety-testing whatsoever. This assessment is misguided. In fact, inadequate testing is less safe than no testing. A laboratory that performs analytical chemistry and microbiology testing is an extraordinarily difficult business to design, equip and operate properly. There are clear and internationally accepted standards for proper laboratory operation, but none of the Cannabis testing laboratories that have opened in the last year currently meet these standards. Many are run by inexperienced analytical chemists, or by non-scientists. Many of them purport to offer tests that are known to be expensive and time-consuming, for far less than the cost of the materials required to perform them. These testing laboratories frequently return only pass/fail information, rather than quantitative results. Most concerning, many reports indicate that when the majority of these laboratories are given identical samples, they return results with very little correlation.

Laboratory Accreditation

It is in the interest of public health and safety to have qualified and regulated laboratories certifying the safety of products. It is better to have *no* testing than to have products sold with misleading certificates of safety.

Adequate safety testing for Cannabis is an attainable goal. Many of the existing Cannabis testing laboratories are now well-staffed and well-funded. Competent laboratories will have little difficulty meeting the accreditation criteria used by both the private sector and the governmental regulatory bodies that oversee the laboratories that test our food, soil, medicines, and drinking water. These criteria are consolidated in the International Organization for Standardization (ISO) guidelines known as ISO 17025 (General requirements for the competence of testing and calibration laboratories), and they are clear, effective, and universally accepted. Most safety-testing laboratories in this country, including many government laboratories at both the state and federal level, are accredited to this standard, by a third-party accreditation body that itself has been shown to operate in conformance to the internationally accepted ISO 17011 standard for accreditation bodies.

The testing of Cannabis must be performed by laboratories that have been able to demonstrate their competence through well-established accreditation mechanisms. Accreditation is a formal recognition by an authoritative third-party of a laboratory's competence to perform specific tests. This accreditation infrastructure is well established by the mutual recognition arrangement (MRA) among accreditation bodies through the International Laboratory Accreditation Cooperation (ILAC). ILAC functions as a forum for harmonizing laboratory and inspection body accreditation procedures and policies, thus promoting accreditation as a mechanism to enhance confidence in testing and inspection facilities. ILAC member accreditation bodies are recognized as competent to accredit testing and inspection organizations through a rigorous peer evaluation process: accreditation bodies must meet the requirements of ISO 17011 and use ISO 17025 as the basis for accreditation of testing laboratories. ILAC was formed more than 30 years ago and the ILAC Arrangement (MRA) has been in place for nearly 15 years.

Many State and Federal agencies utilize the third party accreditation of laboratories as criteria for their recognition, because this status provides assurance that the laboratory is meeting the necessary

quality requirements. For example, the U.S. Consumer Product Safety Commission relies on accreditation of third-party laboratories that are testing in conformance with the Consumer Product Safety Improvement Act of 2008 and requires that children's toys must be tested by a laboratory accredited to ISO 17025 by an accreditation body that is a signatory to the ILAC MRA. In addition, U.S. Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) relies on the ILAC MRA to implement the DoD ELAP requirements for environmental testing laboratories that perform testing in support of the DoD environmental restoration programs.

The government/private sector partnership approach exemplified here has been shown to reduce financial cost and increase manpower resources within those agencies tasked with the responsibility of overseeing such programs. The effect is to maintain accountability and competence while shifting some regulatory costs to private parties, thereby conserving government resources. When a government agency has special requirements for testing, it is common to utilize the existing accreditation programs, augmenting them by developing additional requirements, if needed, rather than developing wholly new and potentially redundant programs.

This approach has become typical within government agencies at the state level, even when the full resources of relevant federal agencies are available. In the case of state-level Cannabis regulation, in which this federal assistance is entirely absent, it makes even more sense for state agencies to rely on this existing and proven mechanism for assurance of laboratory standards.

In August of 2013, the BOTEK organization, which was hired by the state of Washington to consult on the implementation of its recreational Cannabis program, published a white paper on laboratory standards. They stated, "there are certain standards of performance and certification that cannot be realistically met by any lab in Washington, such as the ISO 17025 accreditation. The state must expect it to take some time, perhaps 2 to 3 years, for the Cannabis lab infrastructure to develop capabilities matching those seen in some other testing industries. In the interim, the LCB [Liquor Control Board] may need to rely on a simplified provisional regime of Testing Requirements..."

Whether or not this statement was true in 2013, it is not true now. In August of 2013 Washington State had only three Cannabis testing laboratories; one year later, it has twelve of them. Many of these are

operated by experienced businesses that run Cannabis laboratories in multiple states. Nationwide, there are now at least four separate Cannabis testing laboratories that have received ISO 17025 accreditation. The BOTEK report also indicated that it can take 2-3 years for laboratories to attain ISO 17025 accreditation. This is not the case. Laboratories that are functional and well-run can begin the accreditation process and complete it in as little as 6 months, and certainly within a year. Multiple resources are also available to assist laboratories in preparing for accreditation. ISO 17025 consultants can be hired to perform a gap analysis on their quality system and various training courses are offered by Accreditation Bodies on the basics of accreditation, internal auditing, root cause analysis, etc.

Scope of Accreditation

ISO 17025 does not specify what methods a laboratory uses. Laboratories must themselves define the methods included within their scope of accreditation. In order for a Cannabis testing laboratory to be fully accredited across all of its relevant methodologies, its scope must include identification and quantitation of those components and potential contaminants relevant to public health. These will fall into the following categories.

1. Pesticides. These should be tested for using methods based on AOAC Official Method 2007.01 (or on more effective methods when they become available) with a state-mandated subset of the chemicals specified therein. The Cannabis Safety Institute white paper on pesticides will specify a list that laboratories should be required to test for.
2. Cannabinoids, including, at a minimum, THC, THCA, CBD, and CBDA. This must include extraction methods for dealing with the variety of matrices found in edible products.
3. Microbiology testing: detection and quantitation of all relevant bacterial and fungal species specified in state guidelines.
4. Volatile Organic Compounds (VOCs), often referred to as residual solvent testing (for extracts made with hydrocarbon or organic solvents).
5. Water Activity (a measure of water available to support microbial growth; not substitutable by moisture content measurements).

Most established Cannabis laboratories also test for plant compounds known as terpenes. These are not considered harmful, but in view of their increasing importance and the increasing evidence that they contribute significantly to the characteristics of each Cannabis variety, laboratories should be expected to add these tests to their scope. Cannabis testing laboratories should, of course, also include in their scope any other assay required under state law.

Proficiency Testing

Third-party laboratory accreditation can help to demonstrate that a lab is structured properly, that it has adequate documentation of all of its procedures and quality assurance methods, and that it follows these procedures and methods. Additionally the laboratory must ensure is that it has its test methods in control. One means to achieve this is through the use of proficiency testing using blinded samples provided for analysis. All ISO 17025 accredited laboratories must participate in proficiency testing activities when they are relevant and available. This process has been hindered nationally by the difficulty in transporting Cannabis samples between states and an overall lack of accredited third-party proficiency testing programs. However, it is possible to arrange in-state proficiency testing, and it is also possible to transport chemical standards in solvent media between states. At least two third-party organizations have begun to offer such tests. In order for these programs to be adequate they must themselves meet certain standards.

1. Any third party administering an Inter-laboratory Proficiency Test (IPT) must be accredited to the ISO 17043 standard.
2. Proficiency testing must include all of the items on a laboratory's scope, including (at a minimum) cannabinoids, pesticides, microbiology, residual solvents, and water activity.
3. Proficiency test results must be conveyed as numerical accuracy percentages (e.g., Z scores), not simply as PASS/FAIL results. Actual PASS/FAIL results must be calculated based on accuracy thresholds generated by reproducibility studies specific to each assay.

Methodologies

Scientific analysis methods are constantly evolving, and it is not advisable to restrict the exact technologies that laboratories use for particular tests. In cases where particular methods are required because they are superior to others, these requirements should always leave room for improved or entirely new methods to be developed. Such new methods must of course be accompanied by rigorous and verifiable validation data.

Accreditation ensures that laboratories are adhering rigorously to their methods, and proficiency testing ensures that their methods are effective. Nonetheless, there are general classes of techniques that work for certain analytes, and there are individual methodologies that do not work. This information is relevant to state regulators because there may be an initial period during which laboratories are allowed to operate in the absence of full accreditation, or prior to the implementation of adequate proficiency testing programs.

Depending on the interests of the state regulatory authority, it could choose to require that the participating testing laboratories qualify on the basis of obtaining ISO 17025 accreditation prior to recognition by the authority. Alternatively, there is precedence for a provisional recognition by a regulatory authority based upon a three tier approach: the first provisional tier is to provide objective evidence that the laboratory is using correct methodologies and testing equipment (as described below), the second tier for provisional recognition is to submit a complete application for accreditation to the accreditation body, and the third tier is to achieve the formal accreditation recognition status by the laboratory within a set time period (for example within one year). It is possible that many states will allow a provisional period during which laboratories may operate as they move toward accreditation.

We recommend against drastically limiting this type of provisional operation. It is better to perform no testing at all than to perform testing which is potentially misleading or unsafe. However, because it is possible that laboratories will operate provisionally for some short period of time, it will be critical for regulators to be able to identify practices which are unacceptable. One approach to this would be to employ state accreditation agencies, such as the Oregon Environmental Laboratory Accreditation Program (ORELAP), in an ad-hoc capacity to identify laboratories which are egregiously out of conformity with accepted standards. Another, perhaps complementary,

approach would be to identify methodologies which are unacceptable and prohibit laboratories which rely on them from operating. The following information will be useful in this case.

1. *Cannabinoid testing.* The cannabinoids are found naturally in both acid and neutral forms, with the acid form predominating in the plant itself. While THC in the neutral form has the greatest psychoactivity, conversion from the acid to the neutral form occurs readily upon heating (through smoking, vaporization, or baking) with decarboxylation of the acid group. Both the acid and neutral forms have been demonstrated to be therapeutically relevant, but only the neutral, decarboxylated THC molecule is responsible for intoxication. Any methodologies for cannabinoid analysis should be able to detect and quantify both forms. There are many types of chromatography capable of this discrimination. However, GC (gas chromatography) machines are not adequate in this case, unless they are used in tandem with a technique known as "sample derivatization", and with a detector besides the common one referred to as an FID (Flame Ionization Detector). Samples run on GC machines, without prior derivatization, will be decarboxylated upon sample introduction, resulting in the inability to detect the acid forms of the cannabinoids. Most qualified Cannabis testing laboratories use non-gas forms of chromatography, and do not use the FID detector.
2. *Pesticide testing.* Again, laboratories using only GC with an FID detector cannot test for a comprehensive range of pesticides. Pesticide testing is also expensive. Laboratories charging very low rates for pesticide tests are likely not performing them adequately, or at all. Professional pesticide testing typically costs more than \$300 per sample. All laboratories should be able to provide evidence that they have the correct standards – samples of each pesticide compound to be tested for – on hand.
3. *Water activity.* Water activity is a measure of the moisture in a product that is available for microbial growth. It is a critical indicator of the possibility of microbiological contamination. Many laboratories test for moisture content instead, but there is no way to accurately calculate moisture content without calculating water activity first, and moisture content on its own is not a valid safety indicator.

4. *Mobile laboratories.* Mobile laboratories have a history of inadequate testing. The necessary assays cannot be performed properly in this setting. The exception to this rule is those laboratories that have mobile units in addition to a central testing facility, and perform certain tests only at the central facility.

Management

Analytical chemistry laboratories require extremely skilled scientific staff. While many microbiological assays can be run by trained technicians, analytical chemistry requires much greater expertise. In particular, the requirement for accurate cannabinoid extraction and testing in a variety of food matrices is something that cannot be covered by a simple set of known protocols. Only highly trained and experienced chemists can be expected to solve each of these problems properly as they arise. For this reason, we recommend that all Cannabis testing activities be directly overseen by personnel meeting specific academic and training credentials. In particular, laboratories should be managed by a full-time on-site chemist, with a PhD in a relevant field or at least eight years of experience specific to analytical chromatography.

Conclusion

State regulators charged with structuring this entirely new agricultural industry face significant challenges. Safety testing is only one aspect of the overall structure they have to develop; in the absence of the typical guidance regulators receive on such matters from federal agencies, it has been especially difficult to implement. It is, however, a much more critical piece of this new industry than has been widely realized. There are health risks associated with Cannabis in the form of pesticides, fungal spores, and other contaminants. The newness of the industry has encouraged the growth of an amateur and unregulated testing industry. A public health crisis as a result would be catastrophic for this young industry.

So far, states implementing new legal Cannabis programs have generally delayed addressing these issues. In some cases they have attempted to build accreditation or certification programs from scratch, which adds to this delay without necessarily providing adequate standards. Yet infrastructures for determining and verifying laboratory standards already exist. State governments can manage the question of laboratory standards safely and efficiently, simply by relying on these existing accreditation bodies.

Accreditation to the internationally accepted ISO 17025 standard for testing laboratories, in combination with a rigorous proficiency testing program, is the proven approach for ensuring the quality and reliability of the vast majority of analytical laboratories in the United States. These are the standards used by federal, state, and independent laboratories to ensure the safety of our food and water supply, and the Cannabis industry should be held to them as well. State governments should take advantage of the fact that these standards are both rigorous and straightforward to implement.

Summary of Recommendations

1. All Cannabis laboratories must be certified to the ISO 17025 standard.
2. The assessment and accreditation process must be carried out by a third party accreditation body that is itself accredited to the ISO 17011 standard.
3. All Cannabis laboratories must include all of their methods that have public health implications on their scope of accreditation. This includes, at minimum: cannabinoids, pesticides, microbiology, residual solvents, and water activity.
4. All Cannabis laboratories must pass rigorous and regular proficiency testing programs. These must cover ALL methods on the accreditation scope that carry public health implications. Proficiency testing must be administered by a body that is itself accredited to the ISO 17043 standard.
5. Cannabis testing laboratories must be managed by a full-time on-site chemist, with a PhD in a relevant field or at least eight years of experience specific to analytical chromatography.