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Aerosol Testing for Cannabis Vapor Products

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Aerosol Testing for Cannabis Vapor Products

Executive Summary

Aerosol testing may help better understand the safety of cannabis vapor products. Testing on oil does not fully inform on the health risk of the product because substances in cannabis oil may be transformed upon exposure to the high temperatures required for vaporization. Development and validation of these analytical methods and targets are needed before manufacturers and labs can widely implement aerosol testing. Importantly:

- 1) Aerosol testing should be performed on complete product configurations
- 2) Standardized methods are available from other industries -- but modifications will be required
- 3) There are known targets, but not all compounds of interest have been thoroughly investigated
- 4) Aerosol testing is not the only component of cannabis vapor goods safety

Background

Most states with legal cannabis require some type of analytical testing to inform on the product's safety before the sale of cannabis goods to a patient or consumer. Analytical labs perform testing on finished cannabis goods, similar to food and dietary supplements.

Cannabis vapor goods are unique. In this context, a cannabis vapor good is defined as a manufactured cannabinoid product (i.e., cannabis, THC, or CBD oil) contained in a device (i.e., a vaporizer or vape pen) that, upon user activation, creates an aerosol (i.e., vapor) for inhalation. While the aerosol produced is commonly referred to as a vapor, this is technically incorrect. A vapor is a substance in a gas phase, whereas cannabis vaporizers produce aerosols which are liquids suspended in a gas. For these goods, testing the aerosol produced by the device may complement the testing done at the oil level to provide a more comprehensive understanding of the safety of human consumption. This Fact Sheet presents a summary of considerations regarding aerosol testing¹.

¹In some cases, aerosol testing may also be referred to as emissions testing (e.g., Colorado regulations) while in other contexts emissions testing is used to describe secondhand vapor that may be inhaled by others not directly using the product (Tang, X., L. Cancelada, V. H. Rapp, M. L. Russell, R. L. Maddalena, M. I. Litter, L. A. Gundel, and H. Destailats. 2021. 'Emissions from Heated Terpenoids Present in Vaporizable Cannabis Concentrates', *Environ Sci Technol*, 55: 6160-70. <https://pubs.acs.org/doi/10.1021/acs.est.1c00351?ref=pdf>).



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Aerosol testing should be performed on complete product configurations.

Cannabis vapor products require elevated temperatures (>360°F) to produce the inhalable aerosols, which can differ by cartridge and battery combinations. The temperatures needed to vaporize cannabinoids may transform other chemical compounds (i.e., thermal degradation) in the product, which analytical testing of cannabis oil before vaporization does not address. To understand what a user is inhaling and their risk from product use, aerosol testing is essential. Aerosol testing may give insight into:

- Chemical reactions and degradation that occur with vapor product ingredients and impurities with heat
- Effects of different device settings and functionality
- Materials in the cartridge or device that may be leachable and whether this changes when heat is applied
- Variability between users due to consumption style

Alternative approaches to aerosol testing, such as headspace GC-MS analysis, have been explored. This method uses analytical testing equipment to heat the formulation to a high temperature for a length of time and then measures the thermal degradation products. However, there are significant shortcomings to this approach:

1. The analytical testing equipment cannot reach the same temperatures reached by vaporization devices. Thus, some thermal degradation products may be missed.
2. Cannabis vapor products produce aerosols that are a combination of gas and liquid phases. Actual vaporization of the cannabinoids occurs well above the operating temperatures of most headspace instruments; thus, the composition of the bulk “vapor” is not profiled correctly and does not contain the cannabinoid-enriched liquid phase. Headspace testing only measures the gas phase; thus, this method will miss many substances produced during usage of a vapor product that are only present in the liquid phase.
3. An average draw length on a cannabis vapor product is 3-4 sec, whereas these headspace methods will heat the formulation for minutes at a time. Chemical reactions take time to occur, so a static hold at several minutes will yield different results (in both substances identified and concentrations) than many draws totaling the same duration.



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Standardized methods are available from other industries – but modifications will be required.

The cannabis industry is an entirely different industry and user market from the tobacco and e-cigarette industries. Nonetheless, it may be helpful to look to their longstanding testing methods for aerosol products merely as a reference point for standard cannabis aerosol testing protocol. The tobacco and e-cigarette industries have standardized methods for aerosol testing. This testing is required in Europe by the Tobacco Product Directive (2014/40/EU) and is part of the FDA's guidance for premarket product approval. Though modifications to standard methods will be needed due to differences in consumption styles between tobacco and cannabis (e.g., draw duration, draw volume, the interval between draws, chemical characteristics of cannabis extracts, etc.) and other technical differences, the fundamental approach is identical: a vapor delivery device is attached to a machine which draws the vapor through a trap, the trap collects target compounds, and then the trap is analyzed to determine identity and concentration of compounds in the vapor. The differences mentioned above will require modifications to e-cigarette methods and standardization for cannabis products such as:

- Draw parameters (e.g., draw duration, draw volume, the interval between draw, etc.)
- Traps used to ensure efficient collect aerosol components
- Quantitation methods
- Appropriate controls

Once these methods are standardized, it will be important to validate these methods before using them widely for cannabis vapor good aerosol testing to ensure accurate and consistent results.

There are known target substances – but not all are well established.

All natural compounds, including THC, CBD, and terpenes, break down when exposed to high enough temperatures. While the US FDA has not established target substances for cannabis vapor goods, it is again helpful to draw analogies to cannabis goods by looking at how the agency evaluates inhalable products generally. While devices designed for the inhalation of cannabis vapor are not electronic nicotine delivery systems (ENDS), the US FDA has defined harmful and potentially harmful constituents (HPHCs) recommended for ENDS product analysis. While some of these substances are also applicable to cannabis vapor goods, there are significant differences in concentration, user risk, and chemical identity. Differences are due to chemical composition, inactive ingredients, vaporization temperature, and how the products are used (frequency and dose). ENDS users will often consume over 1g of e-liquid every day. In contrast, most cannabis



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consumers use much lower amounts only a few times a week. Notably, health risk to the consumer is driven by the inherent toxicity of substances AND exposure to those substances, so these differences between ENDS and cannabis vapor products are significant when it comes to health risk.

Toxicologists evaluate the risk for substances present in cannabis vapor products as well as the thermal breakdown products. Regulations should be based on the health risk of the substance(s) of interest in the way in which they're being used AND possible alternatives that they would be replaced with if they are restricted. This approach will prevent regrettable replacements for restricted ingredients and make sure that resulting products are indeed safer. Additional research on cannabis vapor products is essential to provide toxicologists with the needed information to conduct these assessments, which will allow regulators, manufacturers, and consumers to make informed decisions.

Aerosol testing is not the only element of cannabis vapor goods safety.

Good Manufacturing Practice (GMP) standards provide guidelines for manufacturers to follow when designing and delivering a quality product that is consistent, free from contamination, and traceable. GMPs are well established in many industries and are being rapidly implemented across the cannabis industry. In many cases, the GMPs from other industries are directly applicable to the cannabis industry. All of these examples are a part of an overall Quality Management System² applicable to the cannabis industry and should be implemented at the manufacturing site:

- Supplier Controls: audit suppliers' quality systems and utilize only approved suppliers that meet established quality requirements.
- Ingredient and Formulation Specifications: establish requirements for raw materials and formulated products (e.g., identity, purity, viscosity, clarity, etc.).
- Stability Studies: determination of product degradation and shelf life.
- Packaging Controls: perform leachable and extractable studies on the packaging in direct contact with the cannabis product and establish specifications for packaging components and design.
- Surveillance of Customer Complaints: provide a contact for customer complaints, monitor and investigate any customer complaints, take corrective action as necessary.

²Quality Management Standards are available under ISO 9000, ISO 9001, and ASTM D8222-21.



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Conclusion

In conclusion, there can be significant differences in design across different product and device manufacturers that may affect what a user is inhaling. Analytical testing of aerosol emitted from complete product configurations is a better representation of the chemical compounds the user will be consuming and, therefore, user risk than current testing methods. Methods for aerosol testing are not well defined or validated yet, so research is needed to develop and validate these methods before they can be widely implemented.

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