Steep Hill®

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The Problem of Concentrate Consistency: Terpene Loss in Extraction

Cannabis Extraction Methods Alter Terpene Concentrations

The modern cannabis consumer doesn't rely solely on whole-flower methods of consumption. Many modern cannabis consumers—whether medical cannabis patients or recreational consumers—have embraced the convenience, discretion, and rapid relief offered by personal vaping pens or concentrate rigs, which offer consistent, convenient ways to dose discreetly. The question, then, is whether consumers who prefer to use cannabis extracts as opposed to whole-flower use are getting the consistency of experience that they need, as well as the certainty that the product they're purchasing lives up to the chemovar profile of the strain used in its labeling and marketing.

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The terms *terpene* and *terpenoid*—often used interchangeably in common cannabis parlance—do have slight differentiations that are vital to the user experience. *Terpenoid* is the more accurate terminology for terpenes as related to the user experience with extracts and concentrates, as the term *terpenoid* means any terpene that has been chemically modified to produce a specific effect. As most cannabis customers know, terpenes are the class of organic compounds produced by a wide range of plants, with rich amounts—often dozens of terpene concentrations—found in the cannabis plant. The variations in terpenes help consumers distinguish differentiations in specific strains of cannabis, through the aromatic experience, unique taste, and the effects of the strain's terpene composition. Terpenes and terpenoids are the balancing and communicating elements of cannabis-derived products—amplifying, moderating, and enhancing THC activity, interaction with cannabinoids, and engaging the biological receptors of the body to provide a spectrum of physical and psychosomatic effects. By their nature, terpenes are fragrant, typically volatile molecules that evaporate easily, unlike cannabinoids, their odorless counterparts. The term chemovar is used to describe the unique chemical profile of a plant—the plant's "fingerprint." Chemovars are determined by the plant's genomic information, as well as the environmental conditions of the place in which the plant was cultivated. These two factors produce the physicochemical reactions that define the chemovar. In cannabis plants, the chemovar is composed of hundreds of different molecules, which include, most notably, cannabinoids, terpenes, and flavonoids that help define the characteristics of a certain strain or plant varietal.

A recent study by Sexton et al. compared the difference between terpene/terpenoid profiles in cannabis flower with the products of cannabis extractions[1]. In this study, the researchers questioned how chemovar profiles compared between cannabis source flowers and an extract yields, with the flower trim commonly used in supercritical CO_2 extractions considered to be representative of the cannabis flower's unique chemovar profile. In cannabis extraction, a solvent-free extraction method is commonly used to make cannabis concentrate. In cannabis extraction, this is often CO_2 oil, due to its non-polarity (like butane and hexane) and its low critical point of 90°F, believed to preserve much of the delicate plant terpenes and cannabinoids. In Sexton's study, a validated high-performance liquid chromatography/diode array detector methodology was used to identify 42 terpenes common to cannabis. This study determined that during cannabis extraction processes, the products of extraction demonstrated a significant reduction of terpenes, leading to an end-product lacking the whole-plant phytochemical profile. The results identified a potential disconnect in the experience for whole-flower cannabis consumers and concentrate cannabis consumers. The results indicated that the relative terpenoid and cannabinoid contents were significantly different in flower versus in concentrate, often to a high degree. The potency of cannabinoids was shown to be increased by factors of 3-4 fold in concentrates, as compared to the relative potencies of the sample flower. There was an increased presence of ketone, monoterpene alcohols, and sesquiterpenes in the supercritical CO_2 extract as compared to these materials in dried, cured cannabis flowers.

[1] "Evaluation of Cannabinoid and Terpenoid Content: Cannabis Flower Compared to Supercritical CO_2 Concentrate." *Planta Med.*

[2] "Impact of Supercritical Fluid Extraction and Traditional Distillation on the Isolation of Aromatic Compounds from Cannabis indica and Cannabis sativa (2017)". *Journal of Essential Oil Bearing Plants*

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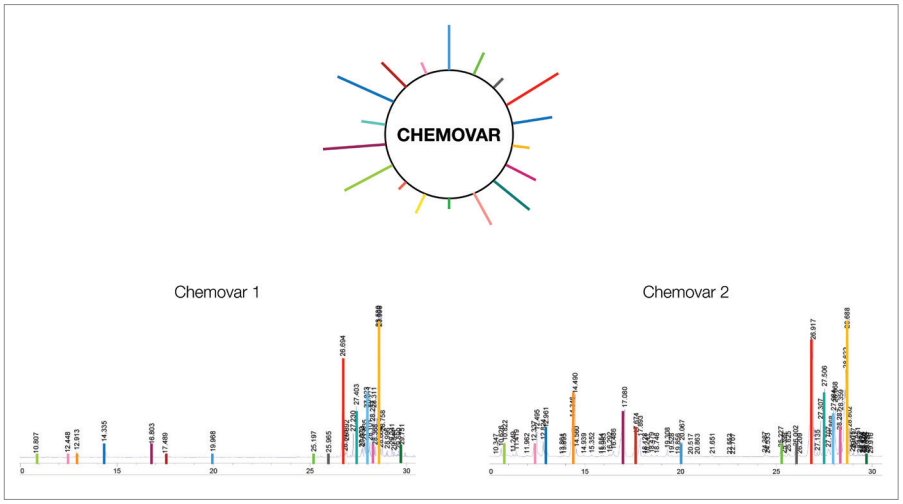
Additionally, the results proved demonstrably that monoterpenes are lost during the extraction process, regardless of the solvents used during extraction. In layman's terms, this means that the products of supercritical CO_2 extraction methods in cannabis provides an end-product that has a drastically different chemotype than the cannabis flowers from which the extracts are sourced. A similar study was performed by Naz, et al, which examined the effect of hydrodistilled (HD), steam distilled (SD), and supercritical fluid extraction (SCFE) yields on *C. sativa* and *C. indica* essential oils[2]. The results compared three different extraction methodologies, each of which indicated that despite the approach, the terpene yields differed significantly in terms of chemotypic profiles from the whole-flowers from which they were sourced. In this study, SCFE yields were shown to have the highest terpene concentrations, but even so, could not deliver terpene concentrations in extracts that rival the concentrations found naturally in whole cured flower. Accordingly, this means that a customer looking for the aromatics, flavor, or effects of a certain strain in a concentrate cannot be guaranteed a comparable experience to the "whole-flower" experience, due to the loss of terpenes during extraction. One might liken the differentiation to ordering a regular soda and being given a diet soda—while it may look and taste similar, it's not quite the same and isn't what you thought you'd ordered. This is especially true in that many consumers perceive as the different effects of indica strains versus sativa strains originate in the terpene profile of the strains in their whole-flower form, an implication that means that this differentiation may also be lost during the extraction process. Moreover, terpene profiles are rarely tested by manufacturers, and even more rarely included on end-product labeling.



Illustrated depiction of analytics of chemotypical variance between natural cannabis flowers vs. products of extractions. Information in this graph provided by Eybna, analytical information represented in this graphic are not part of a scientific or peer-reviewed study.

Concentrates Cannot Provide Consistent Terpene Profiles

What does this mean for the average consumer? First, it means that the extraction of terpenes from cannabis isn't an efficient—or consistent—method of preserving the original terpene profiles of the source material. These studies show that the current naming conventions and consumer labeling habits of most concentrates and extracts don't help the consumer to find the cannabis products that they're looking for. This means that consumers are likely not getting the full effects and benefits of the specific strains that they're seeking when making concentrate purchases based on their naming conventions. The upshot of these studies is this: *No extraction method has been proven to fully preserve the terpene profiles of cannabis in its flower form.* In both studies, the extraction methodologies used by most manufacturers showed significant limitations in replicating the fragrance and flavor of the original materials. In fact, many manufacturers consider their extraction methodologies to be proprietary information, with most manufacturers striving for the highest possible percentages of tetrahydrocannabinol (THC) in their end products. However, as cannabis science evolves to show increasing medicinal and therapeutic benefits of cannabinoids and terpenes, this is akin to the old saying, "Throwing the baby out with the bathwater." The new consumer base is savvy to these advances, and demands more terpene-rich concentrations, prompting the necessity for extract manufacturers to find solutions that will restore terpenes to the oil concentrates, maximizing their therapeutic potential and increasing their market profitability. Sexton's study additionally noted that when selecting a strain for purchase, 60% of consumers rely on the strain's aromatics—the terpenes and terpenoids unique to the varietal. Since scent isn't part of the process of choosing a concentrate, consumers then must rely on their knowledge of whole-flower cannabis strain to guide their choices, which is where the disconnect in the two experiences happens. As an example, consider the following scenario: a consumer finds their "perfect strain", which delivers the medicinal and psychoactive effects they desire. Once a consumer finds their "perfect strain", they will generally become "brand loyal" to that strain, with the expectation of consistency from experience to experience. The consistency of experience, then, is the challenge put in front of concentrate manufacturers—how does a concentrate producer consistently deliver the terpene profiles their customers expect of a strain?

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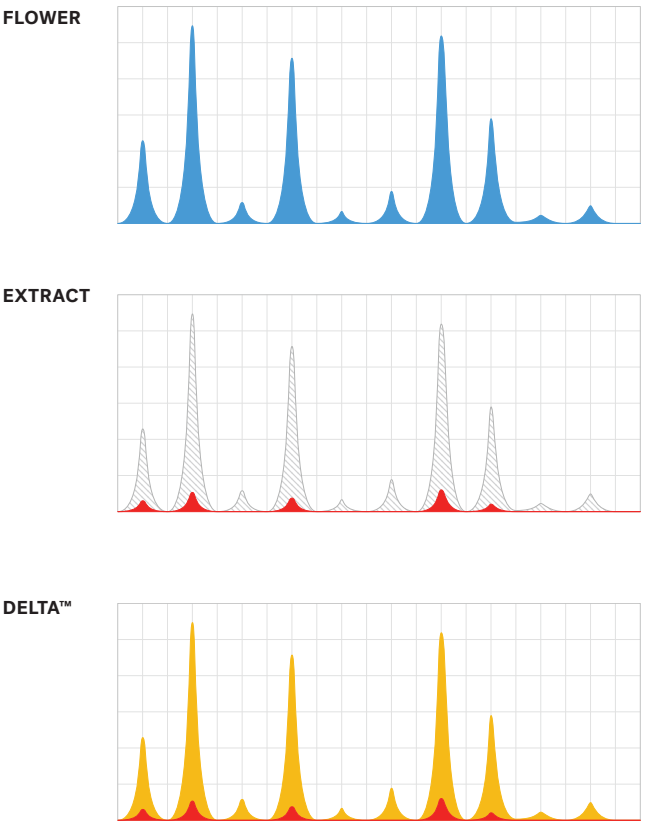
The Solution—Introducing Delta™

How many of us have eaten a watermelon, banana, or strawberry flavored candy and thought that it tastes nothing like the fruit it's supposed to taste like? While the flavor itself may be pleasant enough, we know that we're not getting "the real thing." Many commercial producers are aware that the smell and taste of cannabis concentrates differs from their source strains, and as a result, many companies add artificial flavorings to cover up the missing terpenes or residual taste of solvent. But there's a better solution—a way to restore beneficial and pleasurable terpenes like myrcene, pinene, limonene—and more—to any cannabis concentrate. A way to not only restore the strain's original terpene profile, but to enhance it for a fully customized consumer experience that's consistent over time. Unlike THC and cannabinoids that only exist in the cannabis plant, terpenes are abundant in the world, existing naturally in fruits, spices, vegetables, herbs, and botanicals, many of which are recognized as safe for consumption by the US Food and Drug Administration.

Some of the biggest obstacles for concentrates manufacturers are the inability of a concentrate to match the source flower in terms of taste, smell, or the unique terpene profile that unlocks a specific effect. As more and more concentrate consumers seek out concentrates whose terpene profiles have been restored, it's often difficult to know exactly what you're getting—the "Green Rush" in new cannabis economies had led to an influx of businesses promising to restore lost terpene profiles to concentrates, with varying levels of expertise leading to dubious quality and mixed results. As a manufacturer, your customer base deserves a consistent experience with each purchase, and the only way to ensure that consistency is to trust the industry innovators who have been leading the science of cannabis.

Eybna and Steep Hill have partnered together to bring concentrate manufacturers a solution to the question of consistent user experience with Delta™, an extract analysis and formulation service enabling cannabis concentrate manufacturers to restore natural terpene profiles to their end-products. With Delta™, you can offer customers the whole-flower experience with the convenience of a concentrate and a consistency that no other company can match—a unique way to drive brand loyalty for a sustainable competitive advantage. Your concentrates can be infused with made-to-order terpene formulations, bringing together the essential materials lost during the extraction process to vaporizers, tinctures, oils, and edibles. Contemporary cannabis science estimates over 400 terpenoids specific to cannabis—including myrcene, caryophyllene, and pinene terpenoids, whose medicinal and therapeutic qualities are well-documented. Instead of covering up the missing terpenes with an artificial flavoring, give your customers the unique qualities, taste, aroma, and effects of the whole-flower strain they're looking for in your concentrate, and the assurance that every purchase will deliver the consistency they've come to expect. Delta™ is a unique service in that our terpenes are derived from natural, non-cannabis plant sources that are chemically identical to the materials lost during the extraction process. Because Delta™ only uses top-quality, high purity, natural terpenes, you and your customers can be assured of a consistent experience, product after product, batch by batch. You'll have the capability to not only restore, but to adjust any terpene formulation, creating brand-specific, tailored terpene formulation blends, thereby offering consumers enhanced medicinal and therapeutic qualities. Instead of the difficulty and expense of bringing analytic and formulation experts to your in-house operation to restore terpene profiles to your products, we effectively bring the experts to you. Just imagine what your operation will be capable of, leveraging Steep Hill's analytical expertise and Eybna's formulation mastery. Delta's™ full-service testing and formulation will allow you to match the distinctive qualities of any cannabis strain, for a customer experience that's inimitable, consistent, and as unique as they are.



Illustrated rendering to depict chemotypical variance between natural cannabis flowers vs. products of extractions. PLEASE NOTE: This is an artistic representation of ratios, and not a scientific graph. All information represented in above illustration is intended to be representative of the process, not scientifically accurate to any one study.

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GLOSSARY

Cannabinoid

A class of diverse chemical compounds, meroditerpenoids, that act on cannabinoid and other receptors, in cells that alter neurotransmitter release in the brain.

Chemovar *(chemotype)*

Any chemically distinct entity in a plant or microorganism, with differentiation in the composition of the secondary metabolites.

Delta

In mathematics, delta is used to represent the difference between two different sets of ratios.

Essential Oil

Any concentrated hydrophobic liquid containing volatile aromatic compounds derived from plants.

Hydrodistillation (HD)

A process that is a variant of steam distillation, in which materials are soaked for a period in water. After soaking, the mixture is then heated, carrying away volatile materials in the steam, which are then condensed and separated.

Indica *(Cannabis indica)*

A specific species within the Cannabaceae family, characterized by its short, conical, densely branched stature. In terms of psychoactive effect, cannabis indica is believed to have more bodily, sedative effects and its beneficial qualities include pain relief, anti-insomniac qualities, and its performance as an anxiolytic.

Sativa *(Cannabis sativa)*

A specific species within the Cannabaceae family, characterized by its tall, “leggier” branches and longer, more narrow leaves than its indica counterpart. In terms of psychoactive effect, cannabis sativa is believed to provide more cerebral benefits, including its applications as an analgesic or anti-inflammatory agent.

Steam distillation (SD)

A specialized type of distilling (separating) process intended for temperature-sensitive materials, such as aromatic compounds.

Supercritical fluid

Any substance at a temperature or pressure considered to be above its critical point, at which distinct liquid and gas phases are inexistent. Supercritical fluids can effuse through solids as a gas would and can also dissolve materials as a liquid might.

Supercritical fluid extraction (SFE)

The process of separating one component (the extractant) from another component (the matrix) using supercritical fluids as the solvent.

Terpene *(terpenoid)*

A large group of volatile, unsaturated hydrocarbons commonly found in the essential oils of plants, especially cannabis, conifers, and citrus trees.

Pressure

Any continuous force exerted on or against an object by something in contact with that object.

Yield

The product of any natural, agricultural, or industrial process.

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