Are Cannabis Derived Terpenes Actually Different Than Botanical Terpenes?

TB®

WHITE PAPER 01

INTRODUCTION

2025

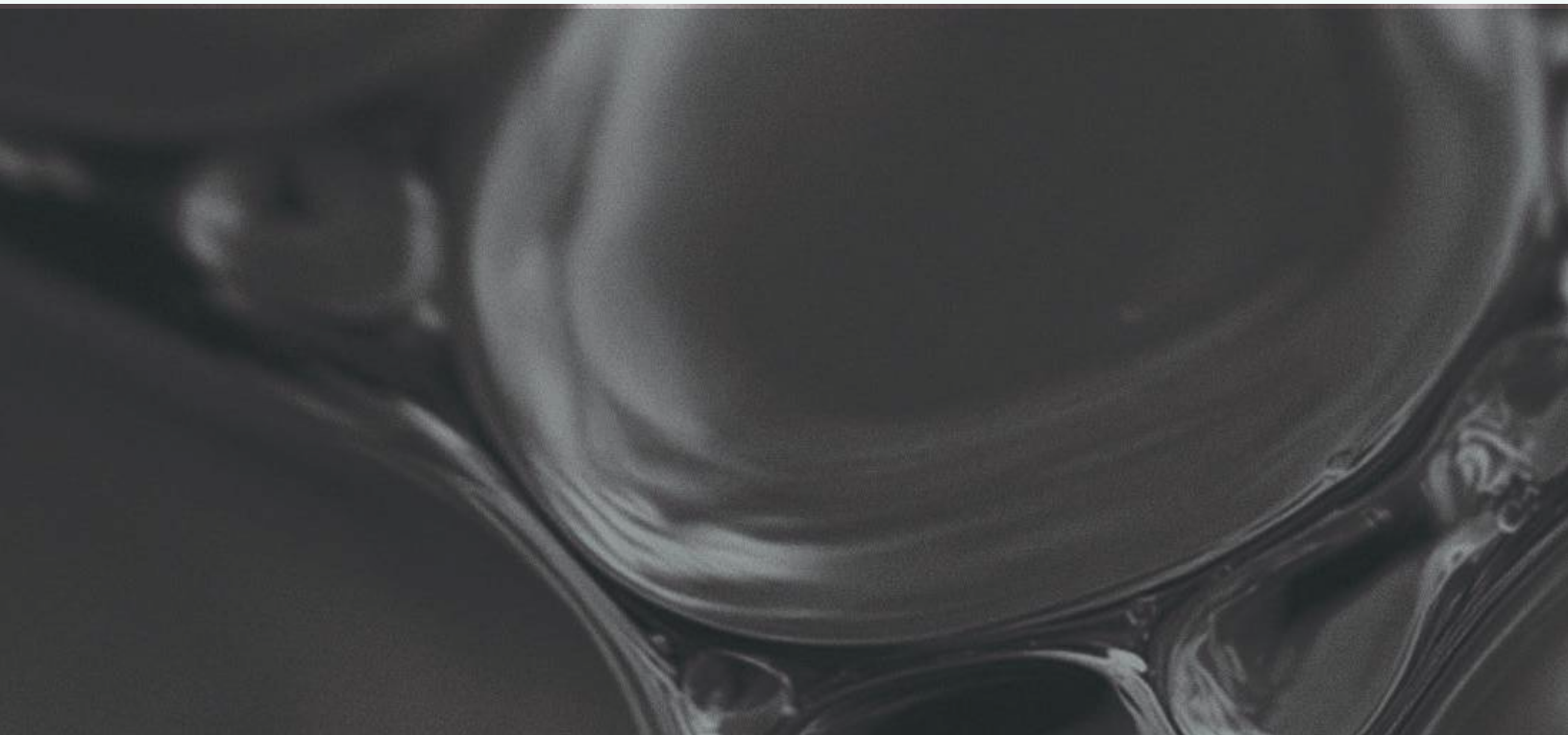
The term **Isomer** is seldom used in the conversation about Cannabis. You are much more likely to hear **propaganda** peddled by botanical terpene providers

> Botanicals are ~~chemically identical~~ to terpenes in cannabis.

Propaganda
noun

[1] Systematic dissemination of ideas, information, or allegations engineered to influence opinions, emotions, or behavior, typically through selective presentation, repetition, or omission of facts.

[2] Material produced for this purpose, especially by governments, political groups, or organizations seeking to shape public perception or advance a particular agenda.



Cannabis & Botanical Terpenes

ARE NOT THE SAME.

≠

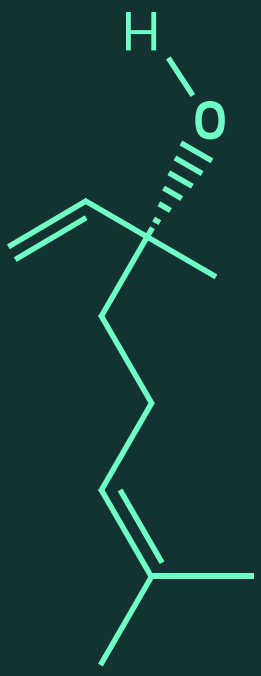
Botanical flavoring companies have built their businesses on recreating popular strains using terpenes derived from non-cannabis sources. While marketing these recreations, it is commonly claimed that any differences are subjective and that chemically, limonene from an Orange is the same Limonene in cannabis. On the surface these claims have merit. The chemical compound limonene does exist in both oranges and cannabis but, in our new isomer analysis, the Limonene in cannabis vs limonene in botanicals may not be as “identical” as many think. Join us on the journey to truly understand cannabis terps, and what makes them so damn special, through the lens of **Isomerism.**

ISOMERISM DEFINED

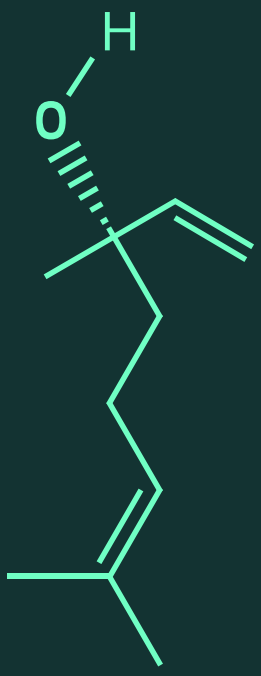
Isomerism is a specialized area of chemistry that can reveal the differences between cannabis derived and botanically derived compounds. If you have ever looked at the chemical composition of a terp profile you likely encountered designations such as.

+ | **−** or **l** | **d**

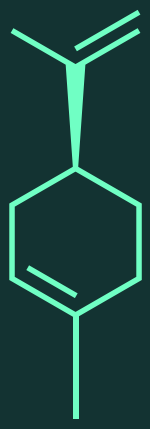
These designations help chemists identify the differences between compounds that share similar constitution but have slight structural differences. These slight differences can lead to completely different outcomes and little has been done to educate brands and manufacturers
because of the need for specialized equipment and techniques necessary to uncover these distinctions. Disclosure of the effects of isomerism has the potential to create waves within an industry that continually strives for parity with the experience of smoking flower.



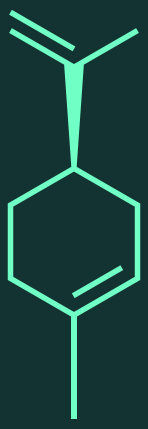
+-Linalool



−-Linalool



l-Limonene



d-Limonene

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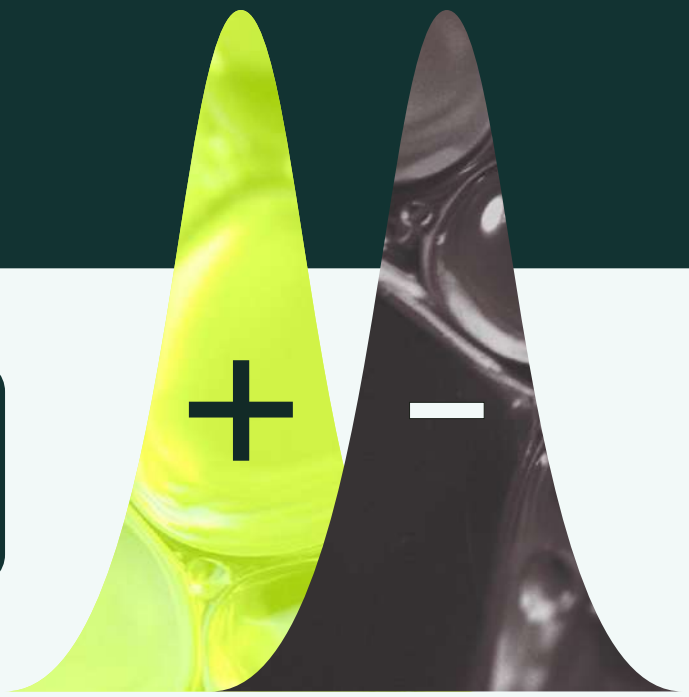
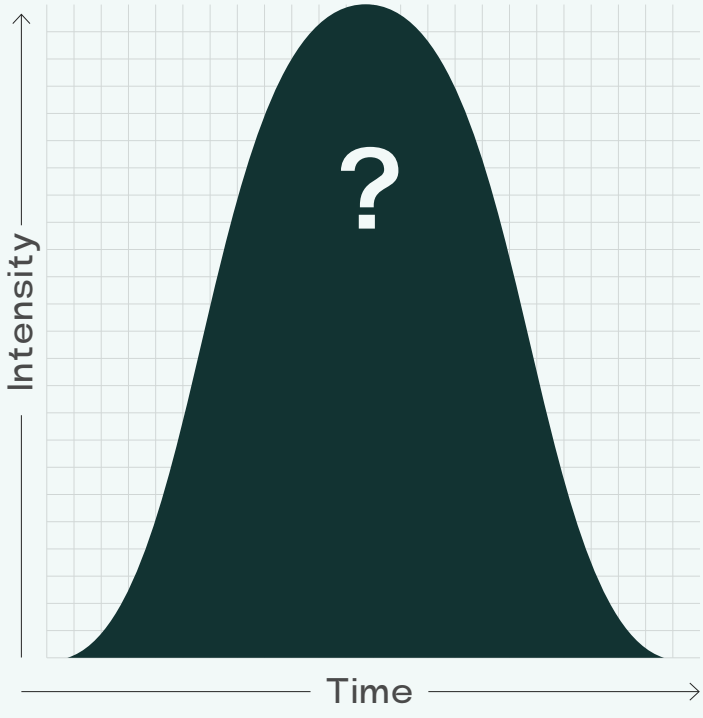
CHIRALITY

How We Identify Isomers



Chiral Column

Enantiomers are molecules which are mirror images of each other at the molecular level but due to nuanced structural differences are not superimposable. That slight difference has meaningful impacts to aroma and efficacy. They are very difficult to resolve, or distinguish from each other, using regular chromatographic methods. On a gas chromatograph (GC), the instrument most commonly used to analyze terp composition, a special purpose-built separation column called a 'chiral column' has to be used to resolve enantiomers so that they can be fed into a detector one at a time. On a regular GC column like the ones used in routine terpene testing, enantiomers come out simultaneously and cannot be distinguished from each other.



Regular Column

3 PRIMARY TERPENES

Lets take a look at 3 of the most commonly used Terpenes.

Limonene
Linalool
β-Pinene

We performed chiral GC analysis on three of our cannabis strains.

- 2024 Fruit #135
- 2024 Purple #103
- 2024 Dessert #45

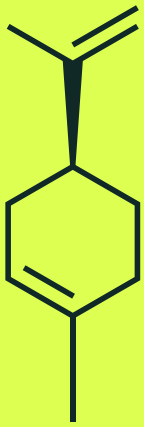
- Botanical Mimic #1
- Botanical Mimic #2

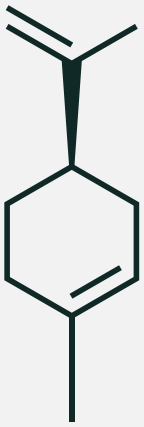
- Natural Orange Oil
- Natural Lavender Oil
- Natural Pine Oil

l-Limonene

S-ISOMER

Piney
Turpentine-like Odor

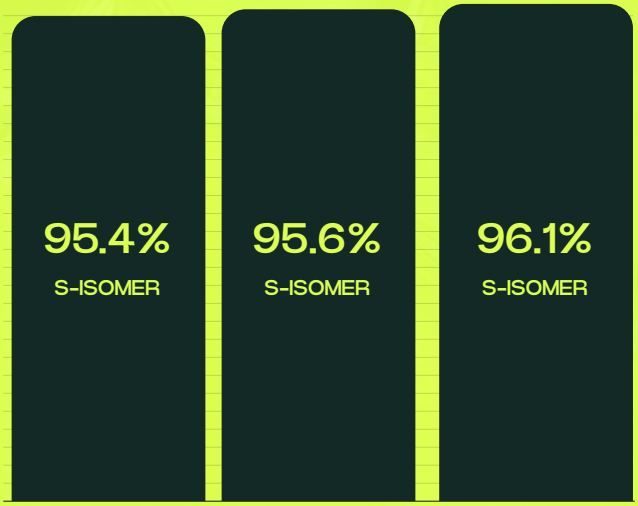




d-Limonene

R-ISOMER

Sweet
Orange-like Aroma

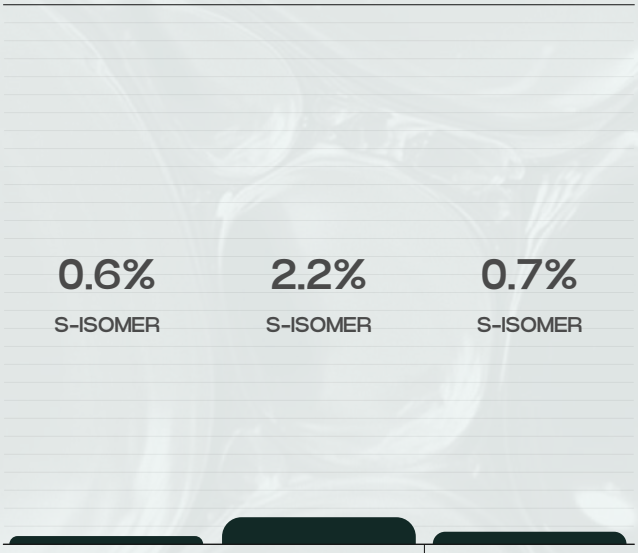


Fruit
#135 • 24'

Purple
#103 • 24'

Dessert
#45 • 24'

TERPENE BELT®



Mimic 1

Botanical
Strain Mimics

Mimic 2

Orange

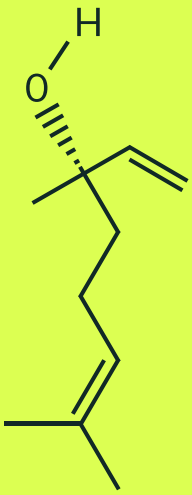
Natural
Source

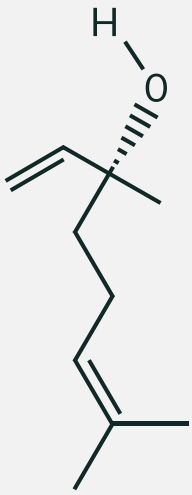
Note that the real cannabis strains have almost exclusively the S isomer of limonene (l-limonene) while the botanicals (especially orange) and the two cannabis mimics are almost entirely composed of R isomer (d-limonene).

(+)-Linalool

S-ISOMER

Sweet, Slightly Citrusy
Reminiscent of Bergamot

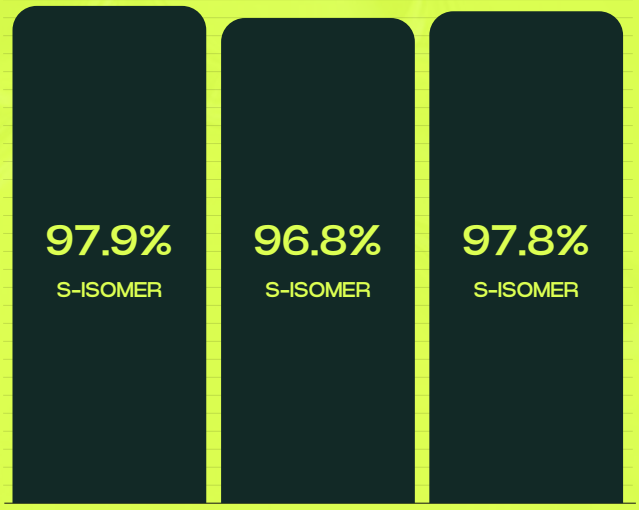




(-)-Linalool

R-ISOMER

Floral, Lavender-Like
Characteristics

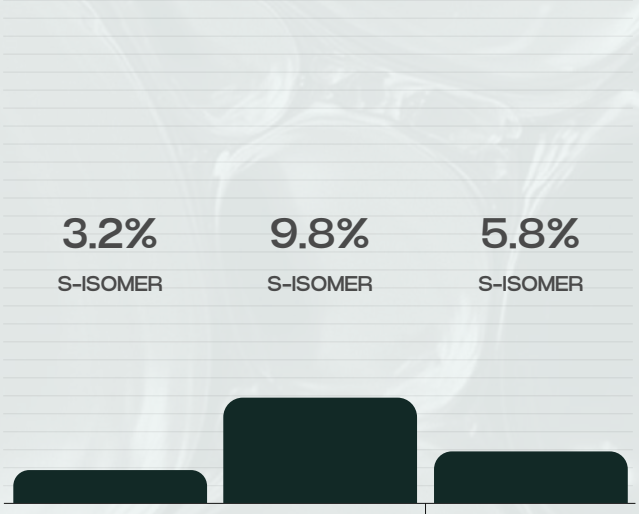


Fruit
#135 • 24'

Purple
#103 • 24'

Dessert
#45 • 24'

TERPENE BELT®



Mimic 1

Mimic 2

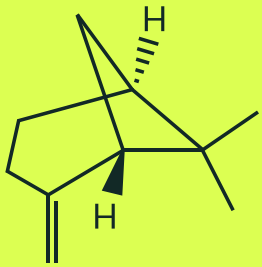
Botanical
Strain Mimics

Lavender

Natural
Source

Note that real cannabis has almost exclusively the S isomer of linalool ((+)-Linalool) while botanicals (especially lavender) and the two cannabis mimics have primarily the R isomer ((-)-Linalool).

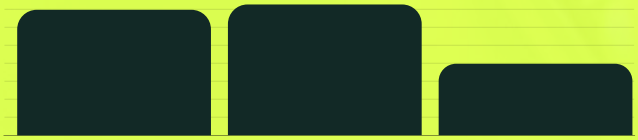
(+)-β-Pinene



R-ISOMER

Herbal, Lemony,
Turpentine-like Scent

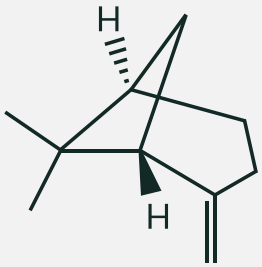
27.0%	28.4%	15.6%
R-ISOMER	R-ISOMER	R-ISOMER



Fruit	Purple	Dessert
#135 • 24′	#103 • 24′	#45 • 24′

TERPENE BELT®

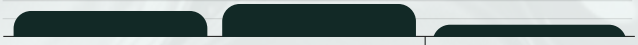
(-)-β-Pinene



S-ISOMER

Woody-Green,
Pine-like Scent

3.0%	3.5%	2.0%
R-ISOMER	R-ISOMER	R-ISOMER



Mimic 1	Mimic 2	Pine
Botanical Strain Mimics		Natural Source

β-Pinene shows more nuance than other compounds but it is of note that while the three cannabis strains have mixed ratios, the pine oil and the cannabis mimics have almost exclusively the S isomer.

Isomerism & Efficacy

Now that we understand the differences in isomerism and stereochemical, it is natural to extend these differences to the therapeutic effects of these various compounds. On the protein level, biochemistry operates with what can be simplified as a lock-and-key mechanism. Just as a mirror image of one's house key wouldn't open one's front door, an enantiomer likely would not interact properly with a receiver intended for its mirror image. There are many known enantiomeric compounds in which therapeutic effects of the mirror image are different; thalidomide, ketamine, albuterol, and limonene, to name a few.

Enantiomers often have different pharmacological properties. While one can provide desirable effects, its mirror image could be inactive or even do harm. Höferl & Buchbauer (2011) reviewed the fundamental principle that chirality affects odor perception, receptor binding, and overall pharmacology in terpenes and other essential oil components. This underscores the need for manufacturers to consider whether their blends maintain the same stereochemical profile as genuine cannabis extracts.

Limonene enantiomers specifically show differences in antimicrobial and anticancer activities. Sun (2007) reviewed the distinctive bioactivity of d-limonene, noting its well-studied chemopreventive and anticancer properties in rodent models. By contrast, its optical isomer l-limonene has been less studied and may not deliver the same outcomes.

Just as the pharmacological properties of (+)-limonene and (-)-limonene differ, the same goes for (+)-linalool and (-)-linalool. Höferl and colleagues (2006) demonstrated that the (R)-(-)-linalool enantiomer exhibits significantly stronger sedative and anxiolytic effects in animal models than its mirror-image (S)-(+)-linalool.

Note that the **Real Cannabis Strains have almost exclusively the S isomer** of limonene (l-limonene).

Note that the **Real Cannabis Strains have almost exclusively the S isomer** of linalool (+)-linalool.

Aprotosoaie and colleagues showed that (-)-linalool exhibits stronger sedative, stress-relieving, anticonvulsant, and anti-inflammatory effects, while (+)-linalool is generally less potent and can even produce mild activating cardiovascular effects. Racemic linalool typically falls in between but aligns more closely with the (-) enantiomer. These differences underscore the need to evaluate functional benefits with attention to chirality (Aprotosoaie et al., 2014).

Botanical blends often fail to preserve the natural enantiomeric distribution found in cannabis, potentially altering their pharmacodynamic effects.

As such, therapeutic outcomes may differ between cannabis-derived terpenes and synthetic or botanically derived mimics that do not match the native stereochemistry.

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White Paper 1

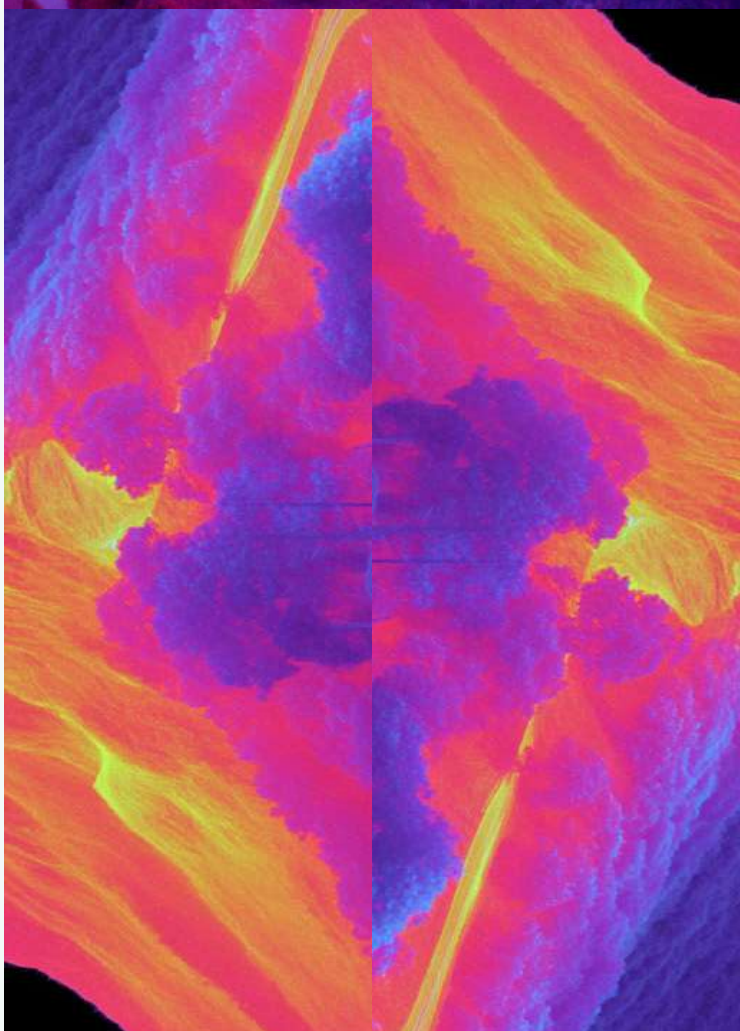
Cannabis Derived Stands Alone

2025

To compare the stereochemical of cannabis oil with other botanical sources we will use a term called enantiomeric excess (ee). Ee is a representation of chiral purity. A racemic (50/50) mixture of an enantiomer pair has an ee of 0%, while a pure enantiomer has an ee of 100%. We performed Principal Component Analysis (PCA) on the ee values using the full data set of 11 compounds and in this visualization it is clear that the stereochemical profile of cannabis stands alone.

The pattern seen here with this limited data set can be observed repeating itself across a wide range of compounds commonly used in cannabis vape products. Botanical flavoring companies have defaulted to the most abundant, readily available source of any and every compound without considering if the compound is truly “chemically identical” or not. This lack of attention to detail has led to the proliferation of vape products that lack the underlying therapeutic benefits found within the cannabis plant and the promotion of ingredients that diverge from naturally occurring cannabis flavor.

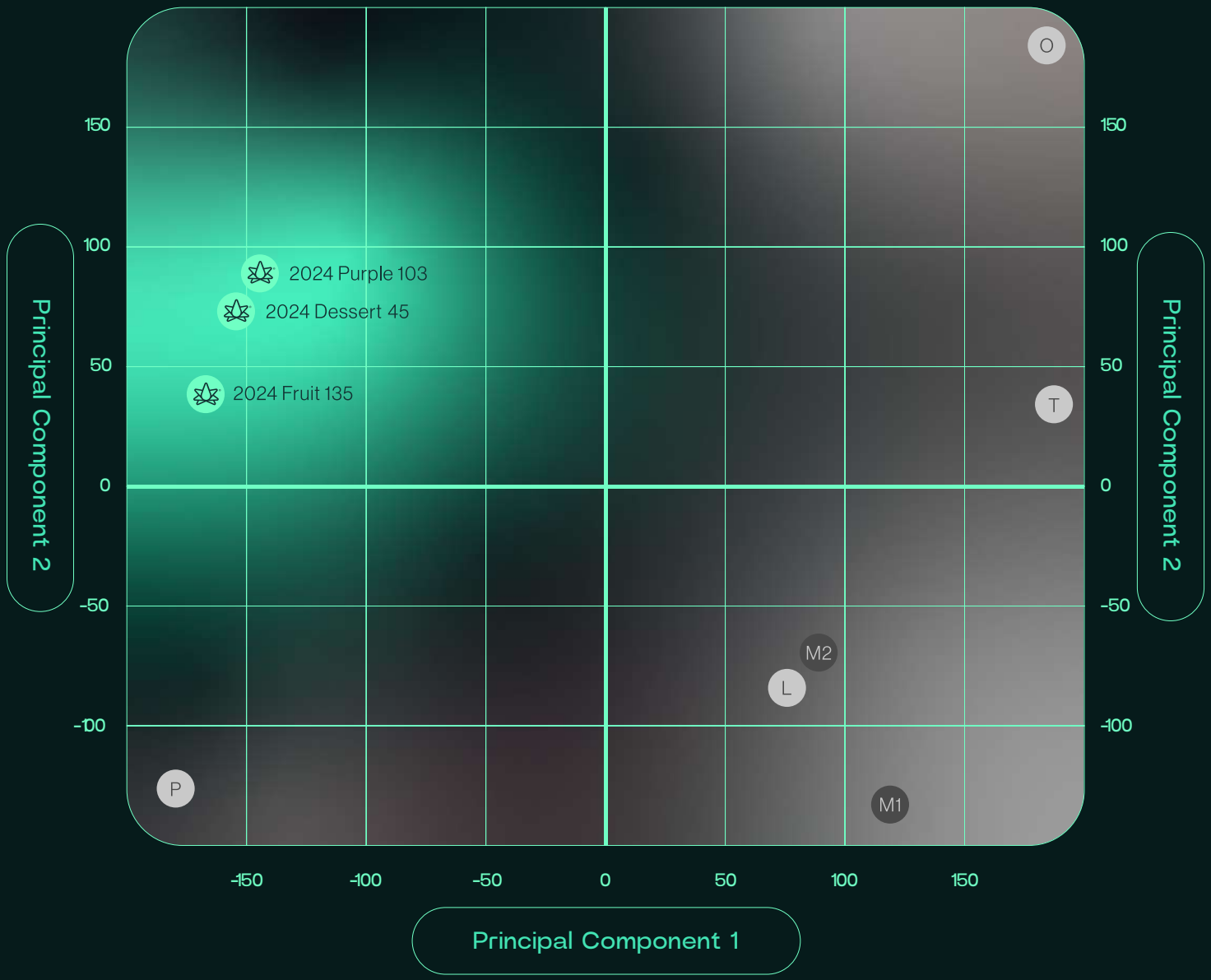
α- and β-pinene provide notable examples of stereoselective biological activity. In particular, the (+)-enantiomers of both α-pinene and β-pinene demonstrate potent antimicrobial effects, showing activity against a spectrum of pathogenic fungi such as Candida albicans and Cryptococcus neoformans, as well as methicillin-resistant Staphylococcus aureus (MRSA). These enantiomers disrupt fungal biofilms, inhibit virulence factors, and exhibit synergistic effects with conventional antibiotics such as ciprofloxacin, substantially lowering MIC values (Silva et al., 2012). Conversely, the (–)-enantiomers of both compounds lack comparable antimicrobial efficacy, with no significant activity observed even at high concentrations (Silva et al., 2012).



Beyond antimicrobial effects, studies suggest stereoselectivity may also apply to antiviral, anti-inflammatory, and neuroprotective actions. For example, (–)- α-pinene has demonstrated potential antiviral activity against infectious bronchitis virus, suggesting a distinct pharmacological profile from its (+)-counterpart (Chen et al., 2011). These findings have direct implications for terpene formulations intended to replicate cannabis profiles:

PCA of Enantiomeric Excess (All Compounds)

2024 Purple 103	Orange (O)	Lavender (L)
2024 Dessert 45	Thyme (T)	Cannabis Mimic 1 (M1)
2024 Fruit 135	Pine (P)	Cannabis Mimic 2 (M2)



Now we can definitely say mixtures of botanically derived components blended to mimic cannabis are **NOT THE SAME** as the real thing in flavor or effect.

While many folks that work in the industry are cannabis purists and have favored the use of cannabis derived ingredients over artificial ones, their reasoning has been anecdotal or preferential at best.

Now with this glimpse in the world of isomerism, we now can definitely say what we have been feeling all along;

> **Botanical mimics used in cannabis vaporizers do not taste the same as the real thing nor do they feel the same as the real thing.**

CITATIONS

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