THE LOST TERPENE

JULY 10, 2022 - A CASE STUDY BY:

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INTRODUCTION

For decades, the cannabis community has generally referred to different cultivars, commonly known as strains, as either being "sativa" or "indica." This nomenclature was birthed in two parts. The first refers to the "sativa" category, which was first used by famed taxonomist Carl Linnaeus when cataloging cannabis. He referred to this species, which had narrow leaves and grew like a tree, as *Cannabis sativa*. Later in 1785, Jean-Baptiste Lamarck cataloged and described a seemingly different species of cannabis that was more bush-like with broader leaves that he named *Cannabis indica*. Since this classification was established, the cannabis community has broadly, and at times in a very hand waving manner, utilized it to help refer to specific types of cannabis with specific psychoactive effects. For instance, sativas are generally considered more energetic with greater focus, but can also lead to paranoia or anxiety. Indicas on the other hand are considered more relaxing, to the point where some users describe the effects as being "couch-locked."

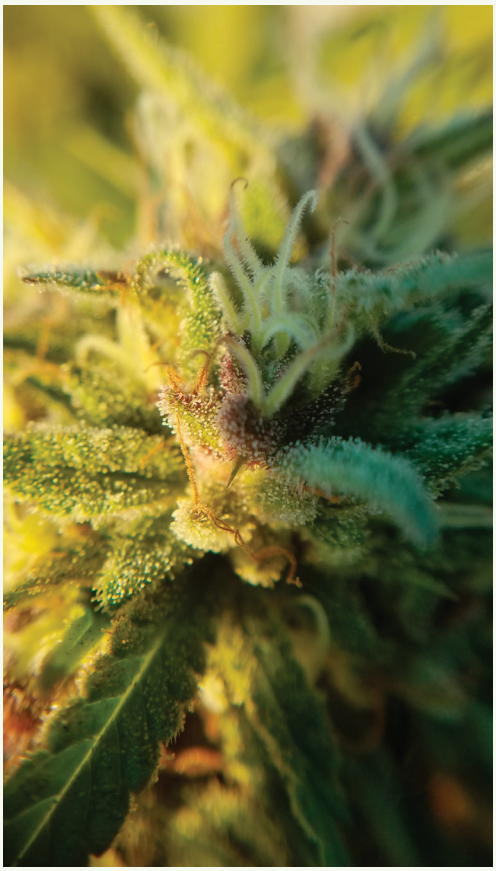


Figure 1. Jack Herer during the flowering stage of growth.

Essentially every cannabis cultivar that consumers may encounter will likely have some sort of categorization into either the sativa or indica category. However, recent research on genetic variation and the supposed indica and sativa classifications shows that much of this naming is incorrect. Thus, it begs the question whether these naming systems mean anything at all. If a flower is mellow and relaxing, but is classified as sativa, how will the consumer trust this naming system? Fortunately, there are certain cultivars that are guaranteed to give users a consistent and predictable experience. Here we describe one such cultivar: Jack Herer, often referred to as Jack **(Figure 1.)**

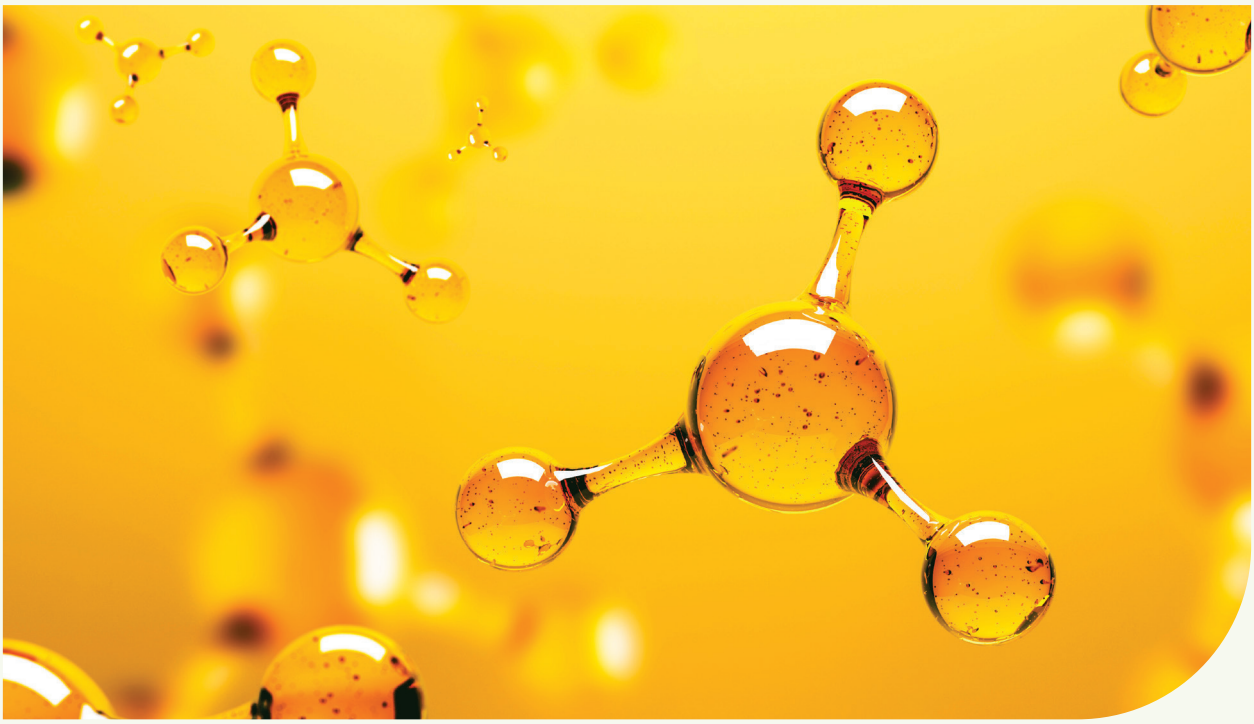
When it comes to cannabis, there aren't many people who haven't heard the name Jack Herer.

Figure 2. Jack Herer inflorescence.

Jack Herer **(Figure 2)** is a famous and ubiquitous cannabis sativa cultivar. It was named eponymously to honor the late Jack Herer, the godfather of modern hemp and one of the most important activists in promoting cannabis deregulation.

This variety produces immense buds that are infamous for the energetic and focused effects they produce. Sensei Seeds first bred Jack Herer in the 90's by combining a Haze cultivar with Northern Lights #5 and Shiva Skunk. Although technically only 55% sativa by the phenotypic classification of its lineage, it is known to produce tried and true euphoric, cerebral, and uplifting effects which easily classify it as a sativa.

In addition to predictable effects, Jack Herer is also legendary for its aroma. The scent is described as bright, woody, and citrusy, but what is it that makes Jack so unique? By using 2-dimensional gas chromatography coupled with mass spectrometry, we have identified the key compounds and their concentrations that make Jack so special. Below we describe some of the attributes of the chemical profile of Jack Herer flower and what makes it so distinctive.



Understanding the aroma of Jack Herer on the molecular level

To understand all of the detail and nuance of a certain cannabis cultivar's aroma, it is necessary to break down its aroma into all of the chemical constituents, referred to colloquially as terpenes. Doing this allows us to understand what kinds of compounds are present, as well as to approximate the amount of each. But the aroma of cannabis is highly complex, with hundreds of compounds reported to exist in this plant. Only by using 2-dimensional gas chromatography, GC×GC, were we able to elucidate the fine details of the aroma. For an explanation of our technologies and instrumentation, click here.[1] This technique reveals many more compounds than using traditional 1-dimensional gas chromatography.

Using this method, we have detected over 350 compounds in Jack Herer. Just as importantly, we have been able to determine with great accuracy the majority of these compounds. These two facts have allowed us to not only understand the scent of Jack Herer in greater detail than ever before, but they also give us the information necessary to replicate the flavor and aroma of this cultivar with great accuracy and precision. **Figure 3** shows the top 20 terpenes detected using our technique on a sample of Jack Herer flower.

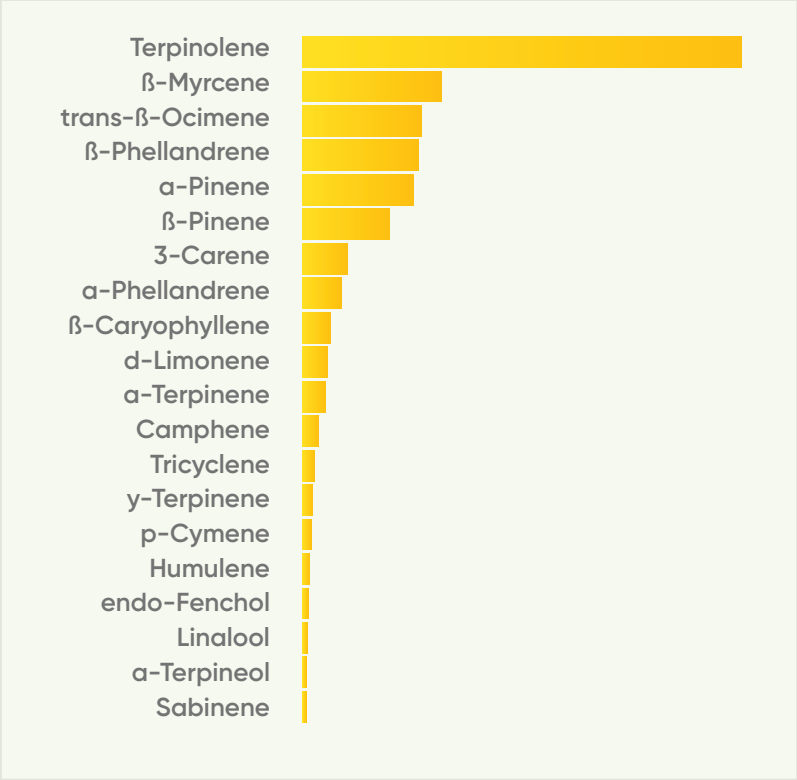


Figure 3. Aroma profile of major compounds found in Jack Herer flower sample.

The most important aspect of Jack, which aligns it with many other classic energetic cultivars, is the large amount of Terpinolene. For instance, other energetic cultivars with this terpene present in high amounts are shown in **Table 1**. This compound engenders Jack with some of the quintessentially bright aromas it produces.

CULTIVAR	HIGH TERPINOLENE?*	EFFECTS	AROMA
Jack Herer	YES	Energetic, euphoric	Woody, citrus
Durban Poison	YES	Energetic, productive	Woody, citrus
Super Silver Haze	YES	Energetic, happy	Woody, citrus
Sojay Haze	YES	Energetic, uplifting	Woody, citrus, floral

*High Terpinolene is defined as the terpene with highest concentration as measured internally at Abstrax Tech.

Table 1. Cultivars with similar chemical aroma profiles as Jack Herer.

Shown in **Figure 4** are some key aroma compounds found in Jack Herer identified in our GC×GC analysis. We found Terpinolene accounting for over 30% of the total aroma content. After Terpinolene, other woody, citrus and floral-leaning terpenes such as ß-Myrcene, d-Limonene and cis-ß-Ocimene occur in high concentrations. But most importantly, and a detail that is overlooked – if not omitted completely – is the presence of ß-Phellandrene. This compound is not to be confused with a-Phellandrene. which has a more citrus and herbal aroma. ß-Phellandrene on the other hand has citrus, spicy, terpenic, and mildly minty base notes that creates a more nuanced aroma in Jack. While many analytical cannabis labs will identify a-Phellandrene in cannabis and routinely test for it, none are currently suited to detect and quantify ß-Phellandrene to our knowledge.

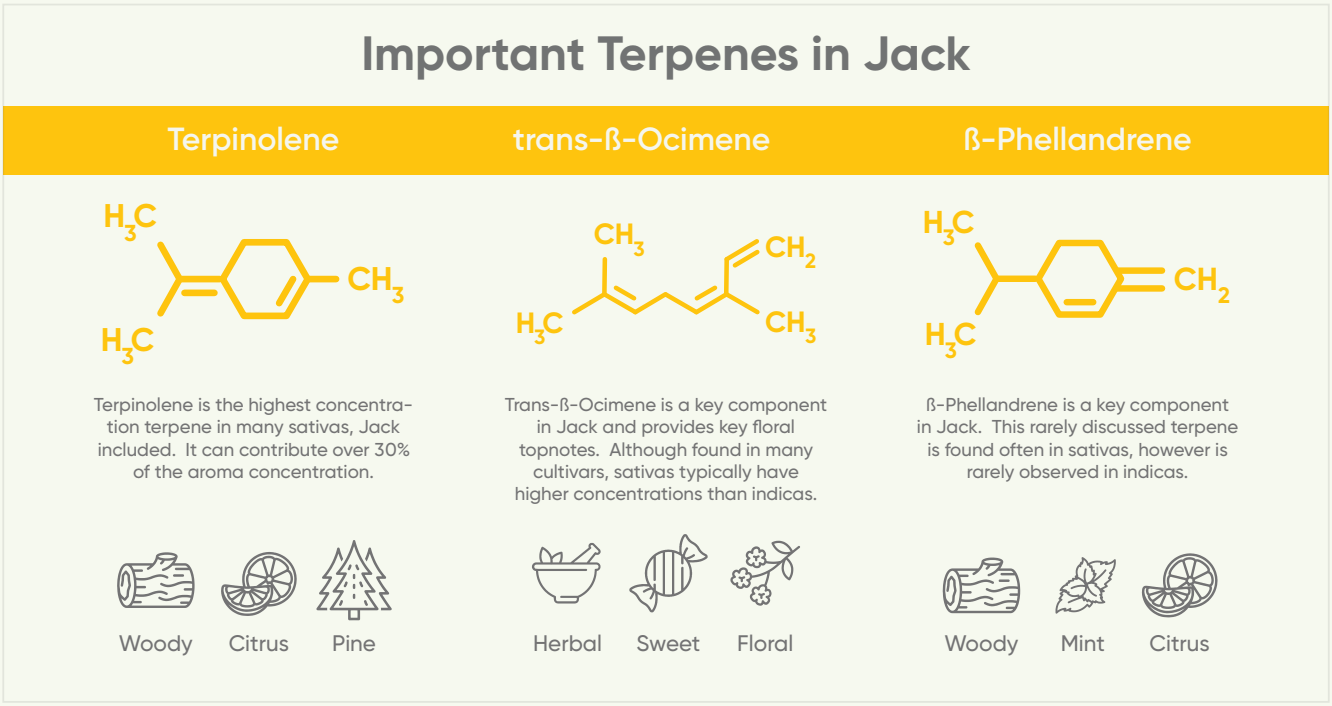


Figure 4. Some key terpenes in Jack that drive its unique flavor.

In fact, this terpene is rarely discussed in cannabis literature yet is ubiquitous in nature. It is found in many plants including cumin, black currant, and dill. Its obscurity within terpenes discussed in cannabis is possibly because it tends to elute very closely to other similar terpenes such as d-Limonene, p-Cymene, and numerous Ocimene isomers **(Figure 5)** and thus is difficult to elucidate in the data.

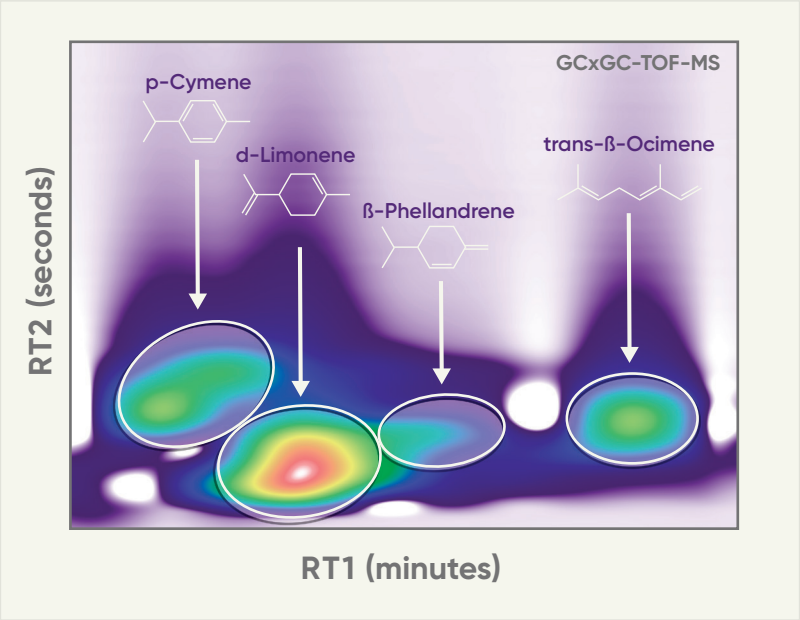


Figure 5. GC×GC peaks showing numerous compounds eluting near each other. Without mass spectrometry, ß-Phellandrene is essentially impossible to detect, let alone identify.

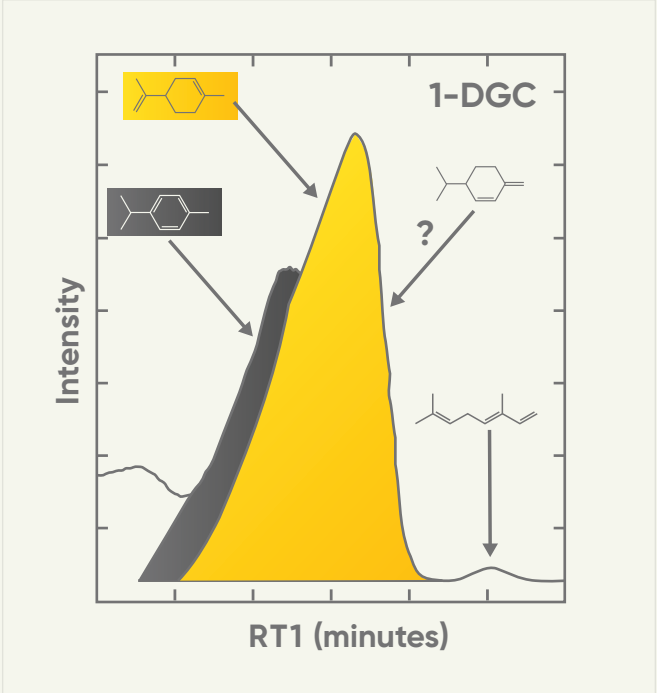


Figure 6. 1D chromatogram showing the convoluted peaks of p-Cymene, d-Limonene, and ß-Phellandrene. The colors represent the approximate peaks areas that correspond to p-Cymene and d-Limonene. ß-Phellandrene is essentially invisible in this data due to the convolution of data.

This complexity essentially requires mass spectrometry (which many labs do not have access to) to correctly identify and quantify it in the data. Furthermore, the large amount of other co-eluting compounds around ß-Phellandrene make it even more difficult to discern using only traditional 1-DGC. This is shown graphically in **Figure 6**, which shows how this elution appears in 1-dimensional GC data. The colors annotate the approximate contributions to the peak intensities from two of the more commonly identified compounds, p-Cymene and d-Limonene.

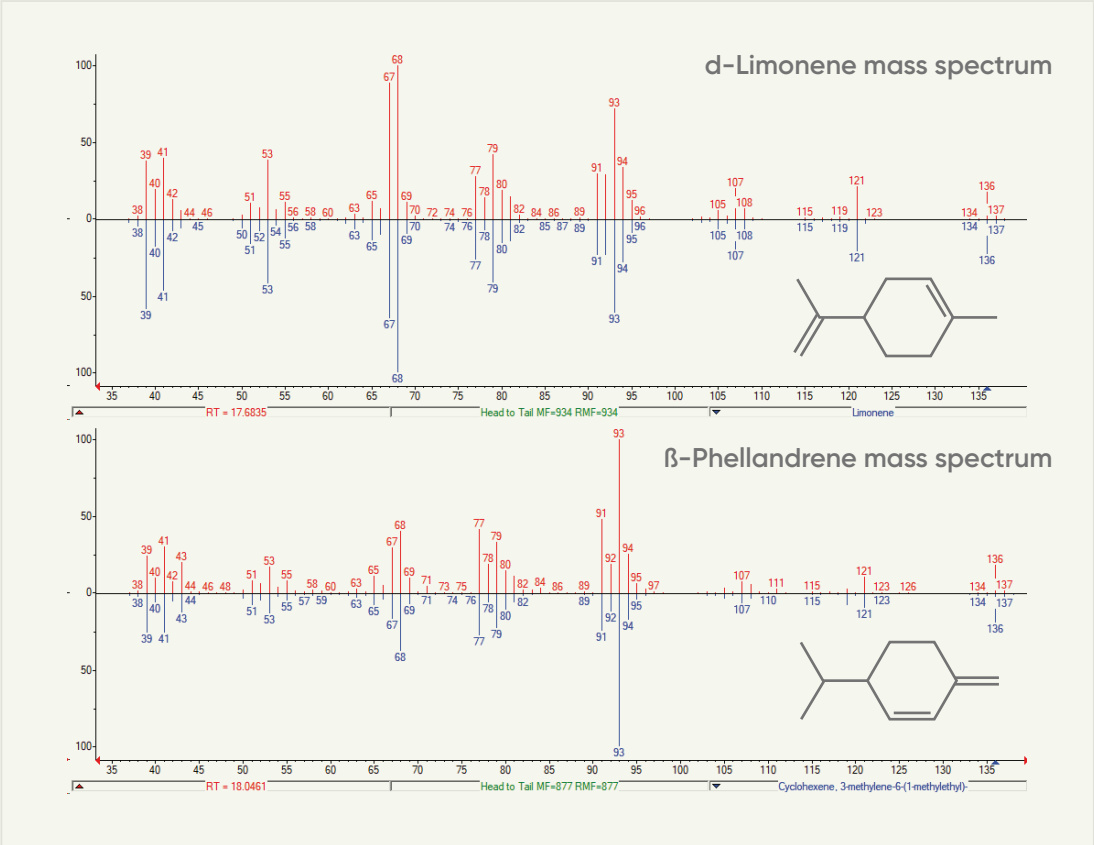


Figure 7. Mass spectral data of two similar terpenes that elute near one another using GC×GC. Red lines show the mass spectrum of our data; blue lines show known mass spectrum of each compound in the NIST mass spectral database. The similar peaks confirm the identities of both compounds.

Identifying ß-Phellandrene in this peak becomes an arduous task, along with quantifying p-Cymene and d-Limonene. Fortunately, this issue is alleviated in GC×GC due to its greater separatory power. By combining GC×GC with time-of-flight mass spectrometry, we easily identified two dissimilar mass spectrums near d-Limonene **(Figure 7)**, which revealed ß-Phellandrene to elute nearby. Each compound is then quantified analytically by using custom chemical standards.

CONCLUSION

Taken together, we describe some of the important details of the cultivar Jack Herer, also known as Jack, and what makes it special. Jack is a quintessential sativa that has a vibrant, bright, and citrus-woody aroma that provides classic sativa effects. Our analysis using 2-dimensional gas chromatography of this cultivar reveals high levels of Terpinolene such as seen in other sativas. However, it also possesses a more unique and rarely discussed terpene, ß-Phellandrene. This compound is found in relatively high concentrations and thus is critical to the flavor and aroma of Jack, thus highlighting the need for more sophisticated analytical methods such as GC×GC when understanding the aroma of cannabis.

References

(1) The Science of Dank - Discovery of New Cannasulfur Compounds https://abstraxtech.com/blogs/news/discovery-of-new-cannasulfur-compounds.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