PART II: THE CURIOUS CASE OF CHEM

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FOREWORD:

The aroma of cannabis is evolving, becoming increasingly diverse and complex due to the work of breeders across the world, who have sought the newest, most unique aromatic notes possible. While they have done so with great success, the chemical understanding for why many of these varieties smell the way they do has historically not been well understood.

The terpene concentrations of two cultivars can be very similar and yet have widely different aromas. There are cracks in our current understanding of cannabis knowledge.

Our recent publication has transformed this understanding by introducing entirely new classes of compounds that distinctly influence the aromas of specific varieties.[1] We initiated research in collaboration with top breeders in the industry along with 710 Labs, a leading cultivation and extract company, and analytical instrument experts, SepSolve Analytical and Markes International. Our goal was to address the most pressing questions about cannabis's unique aromatic properties

This work unveiled many compounds never reported before in cannabis literature.

To help explain the most important aspects of this research, we present a series of white papers focused on key aspects of the work conducted.

MARKES International 710LABS SepSolve Analytical

In this second installment, we delve into the captivating chemistry that underpins one of the most distinct aromatic characteristics sought in many cannabis varieties: the intriguing **funky**, **chemical**, and **savory** notes reminiscent of strains like GMO, Chemdawg, and beyond.

We begin by spotlighting two pivotal compounds associated with these aromas: **Indole** and **Skatole**. Following this, we outline their discovery, the specific cultivars they manifest in, and their connection to other naturally occurring compounds found in nature, including their prominent role in psychedelics. Prepare to get stanky.

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INTRODUCTION

It's no secret that cannabis can often smell fruity, piney, or woody. As we detailed in **The Science of Exotic I: The Dawn of Flavorants**, terpenes provide the canvas for the foundational aromas of cannabis, but modern day flower has been bred specifically to push the envelope of exotic flavor & aroma. And while it's often pushed towards the citrusy/sweet end of the spectrum, there is a very unique and, frankly, ***downright weird*** opposing end, as seen in **Figure 1.**

If you have been lucky enough to come across a variety of cannabis that possesses a savory, almost garlic-like aroma, you may have wondered why it smells so uniquely different. Or maybe you're one of the few to experience a cultivar with an almost chemical, ammoniacal scent. Cat Piss, anyone?

Figure 1. Schematic illustrating the divergent nature of the aroma of cannabis. This paper focuses on samples with the "savory" classification.

Varieties with these chemically, savory notes are not necessarily common, but they indeed exist and are often highly sought after. Typically characterized as "indica-leaning", they are renowned for their pronounced **full-body effects**, **high-THC** content, and **distinct aromas** that set them far apart from other varieties.

What gives Chemdawg it's distinctive chemical scent?

What makes GMO so intensely savory?

How is it possible that cannabis can produce such a wide bouquet of aroma?

These questions now have answers, thanks to new research published by Abstrax Tech in collaboration with 710 Labs and Markes International.[1] But before we get into this, we will first discuss what the current science says about the aroma of cannabis.

710LABS MARKES international

The cannabis plant is truly unique in the plant kingdom. It has a propensity to produce a wide array of compounds that are completely unique to itself, as shown in **Figure 2.** These range from cannabinoids – compounds such as tetrahydrocannabinol (THC) and cannabidiol (CBD) – to terpenes, cannflavins, and more. Why this plant produces many of these compounds is still up for debate, but one thing for certain is that ***cannabis is a powerhouse*** in producing unique chemical compounds that can have profound psychoactive effects on humans when consumed.

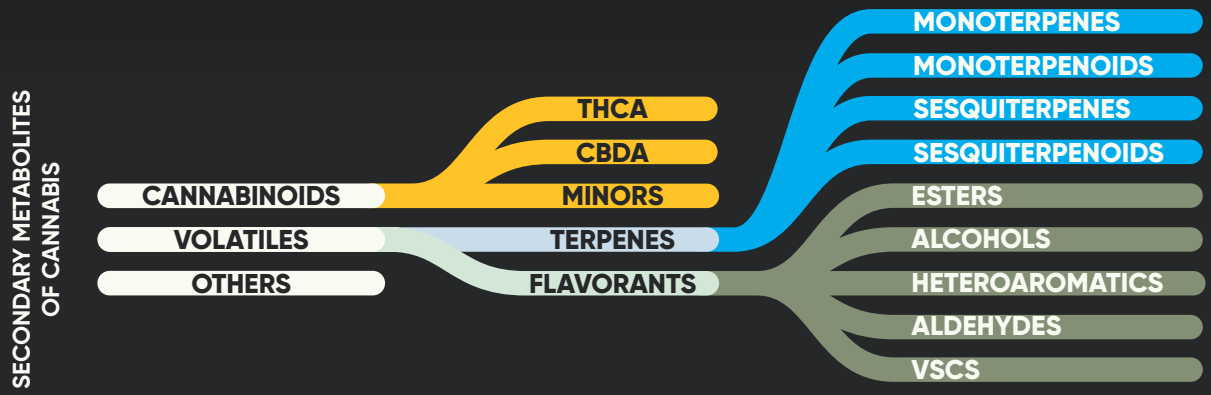


Figure 2. Sankey diagram showing the phytochemical makeup of cannabis.

While THC is the primary psychoactive constituent in cannabis, there is increasing evidence to suggest that the other hundreds of compounds present in a given variety may influence or modulate these effects. This phenomenon is referred to as the Entourage Effect and is being actively investigated to understand why certain compounds beyond THC may modify the effects brought on by consuming a specific strain. Further, these other compounds are responsible for the aroma of cannabis.

WHERE HAVE YOU BEEN ALL MY LIFE?

Understanding the aroma of cannabis is not a simple task. **Analytical labs typically test for only 30 to 40 compounds commonly found in cannabis.**

Although terpenes are frequently discussed in cannabis aroma literature, such discussions don't capture the full essence of its scent, primarily because cannabis emits an unparalleled array of compounds. To date, **Abstrax has identified over 500 distinct compounds** contributing to its aroma.

There are hundreds of different low-concentration molecules present in cannabis that produce potent and unique aromas, much more so than typical terpenes.

For more information, please see the epilogue to find The Science of Exotic I: The Dawn of Flavorants

In 2021, Abstrax unveiled that a novel class of prenylated volatile sulfur compounds, termed "**cannasulfur compounds**," are responsible for the gassy, skunky scent of cannabis.[2] Even though these compounds are found in the **parts per billion**, they create an extremely potent aroma that greatly influences the overall bouquet.

Despite common belief, terpenes aren't responsible for the quintessentially dank aroma of cannabis. We know from our sensory testing that terpenes aren't responsible for the uniquely exotic aromas of cannabis either. And, yet, cannabinoids and terpenes are the two major things tested for at every analytical cannabis lab around the world. **Something is missing.**

Is it possible that the chemical and savory aromas in cannabis could also stem from other low-concentration compounds that haven't been identified yet?

AND SO THE SEARCH BEGAN.

THE SEARCH FOR SAVORY

To conduct this study effectively, **we first sourced fresh, standout cultivars** that exhibited the diverse aromas we aimed to understand. We at Abstrax, being located in Southern California, have access to some of the most premiere and popular varieties on the marketplace. Additionally, **710 Labs** provided samples and procurement suggestions. Thirty-one different varieties in total were collected for evaluation.

One aspect of the study involved deciding what sample matrix would be ideal. There are many form factors of cannabis products, ranging from cured flower to live resin. **We found that ice-hash rosin was an ideal matrix for measuring the low concentration analytes using our instrumentation.**

ICE-HASH ROSIN WAS CHOSEN FOR THREE PRIMARY REASONS:

1

Ice-hash rosin is a concentrated form of cannabis, thus raising the overall levels of compounds in the sample and making it easier to detect them.

2

It is manufactured without exogenous solvents such as butane, thus reducing any sort of contamination or change in aroma profile due to the removal of solvents.

3

Many high-quality, cutting edge varieties with unique aromas are produced by ice hash rosin experts who selectively prioritize the extraction of flavor & aroma.

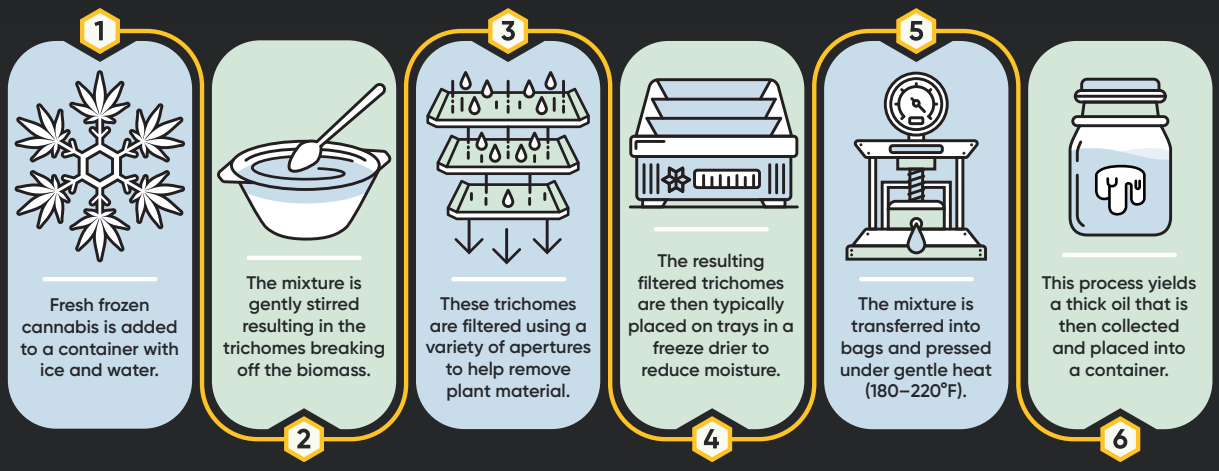


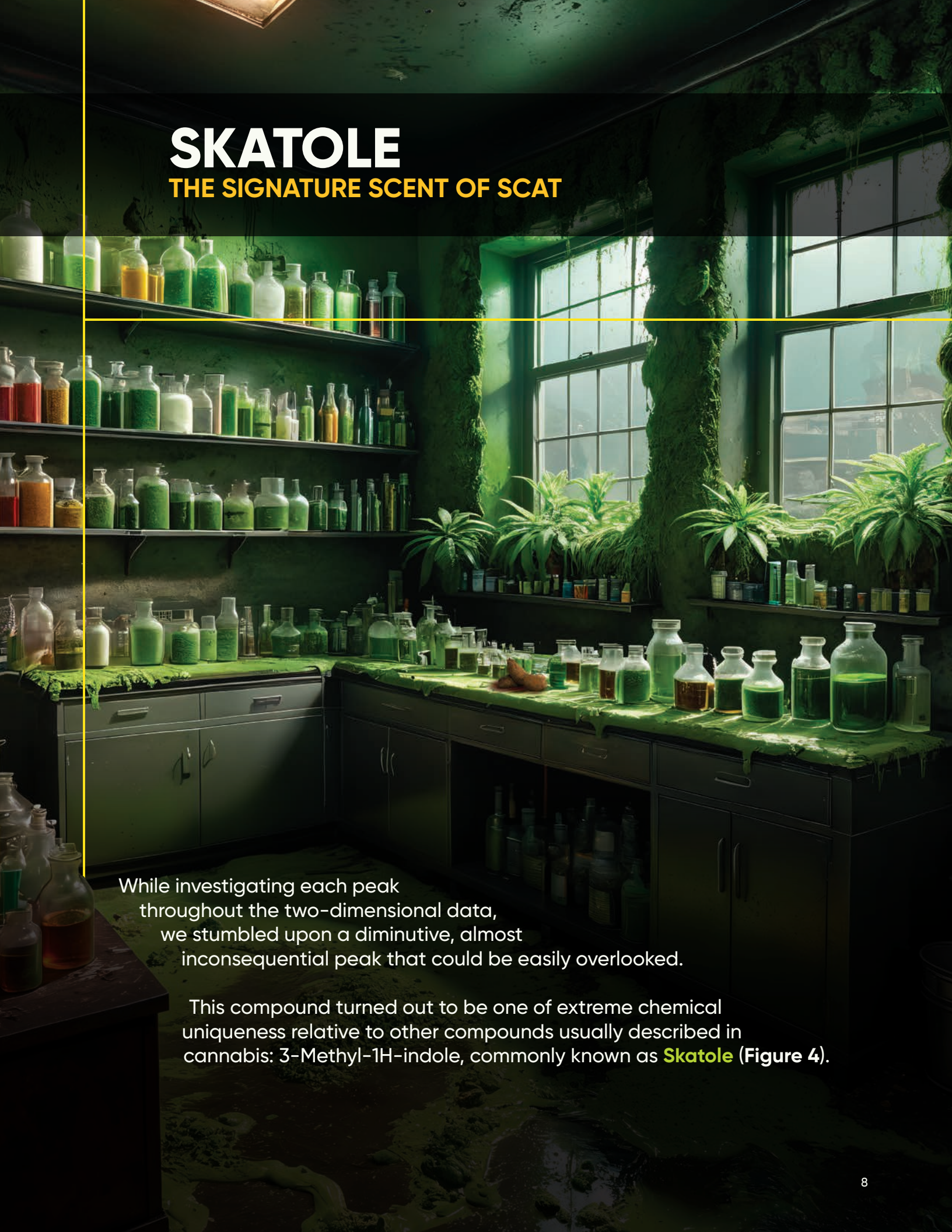
Figure 3. A general explanation of the ice-hash rosin making process.

Cannabis is both an art and a science. The human nose is incredibly adept at recognizing and evaluating aromas, but in order to analyze these samples thoroughly, we needed to perform both a qualitative and quantitative assessment in the form of a sensory analysis and a chemical analysis.

In "The Science of Exotic I: The Dawn of Flavorants," we discussed our team's methodology for comparing cultivars. Now, let's delve into what we've found...

SKATOLE

THE SIGNATURE SCENT OF SCAT



While investigating each peak throughout the two-dimensional data, we stumbled upon a diminutive, almost inconsequential peak that could be easily overlooked.

This compound turned out to be one of extreme chemical uniqueness relative to other compounds usually described in cannabis: 3-Methyl-1H-indole, commonly known as **Skatole** (**Figure 4**).

Figure 4.
Skatole

Skatole is a notorious heterocyclic compound due to its presence in mammalian feces, and is in fact one of the major odor contributors to this familiar scent that we all know (but don't love). However, **Skatole is a bit of a chemical chameleon.**

Although it is most well known for its **foul fecal fragrance**, it can combine synergistically with other compounds to yield novel scents that are ammoniacal, naphthyl (e.g., mothballs), chemical, or even in the correct concentrations, floral.

This is why **Skatole is a key compound in the perfuming industry** even though it requires careful use to obtain the desired aromas. It is also used in other commonly encountered products such as ice cream, highlighting how its unique aroma and flavor can benefit a multitude of different products.

We first identified Skatole in GMO (Garlic Mushroom Onion), which was ranked as the most savory, non-sweet variety out of the 31 measured, as illustrated below in **Figure 5.**

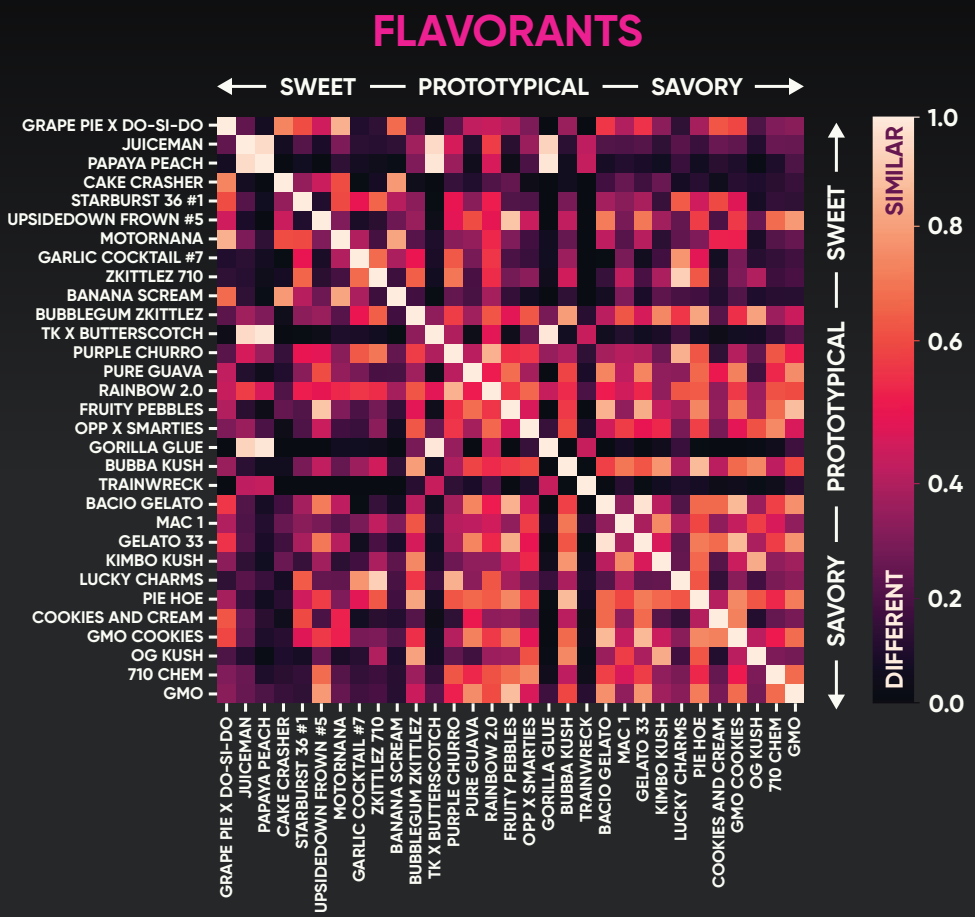


Figure 5. Correlation table of flavorants between the 31 different cultivars analyzed. We can see the similarity between Fruity Pebbles and GMO as indicated by the lighter color.

We then looked for this same peak in the other samples to determine which other cultivars may also contain it. Interestingly enough, cultivars on the "savory" side of the spectrum often contained trace amounts of Skatole.

We found that almost none of the sweet or fruity samples had Skatole present... with two exceptions:

Fruity Pebbles

Fruity Pebbles predominantly exudes a sweet, fruity aroma, carrying a subtle undertone reminiscent of a chemical or "sewer"-like scent.

Garlic Cocktail #7

Garlic Cocktail #7, a unique hybrid cross of GMO and Mimosa, logically contains Skatole due to its exotic genetic lineage.

The sensory panelists observed that **Fruity Pebbles exuded a richer aroma** compared to other sweet exotic strains, a characteristic we believe might be attributed to the presence of Skatole, especially when paired with a higher concentration of fruity flavorants.

This hints that while Skatole's distinctive scent remains discernible, it might also amplify a lush, sweet, exotic fragrance when combined with other dominant flavorants. **In other words - the presence of Skatole might serve as an aromatic force multiplier, greatly enhancing the richness of other aroma compounds**.

Varieties like GMO Cookies and 710 Chem, which ranked among the most savory exotics measured, were also found to contain Skatole, **lending them a noticeable chemical fragrance**. This discovery highlights the crucial part Skatole plays in bestowing the unique, chemically-infused, savory fragrance that distinguishes many cannabis varieties.

Further validation came from reverse engineering the terpene profiles in our lab. Even in trace amounts, **Skatole was found to be instrumental** in creating the signature exotic aroma that is highly prized in these strains.

We also suspect that Skatole might be instrumental in the "overripe" or "rotten fruit" aroma notes in some cultivars. We are currently conducting further sensory evaluations on this compound, along with others in cannabis, to better understand their roles in shaping these distinctive scents.

Interestingly, Skatole not only amplifies the chemical and savory undertones of cannabis but also **seems to intensify the gassy aroma** emanating from prenylated cannasulfur compounds. The synergy of these potent odorants is what drives the exceptional aromatic strength of such varieties.

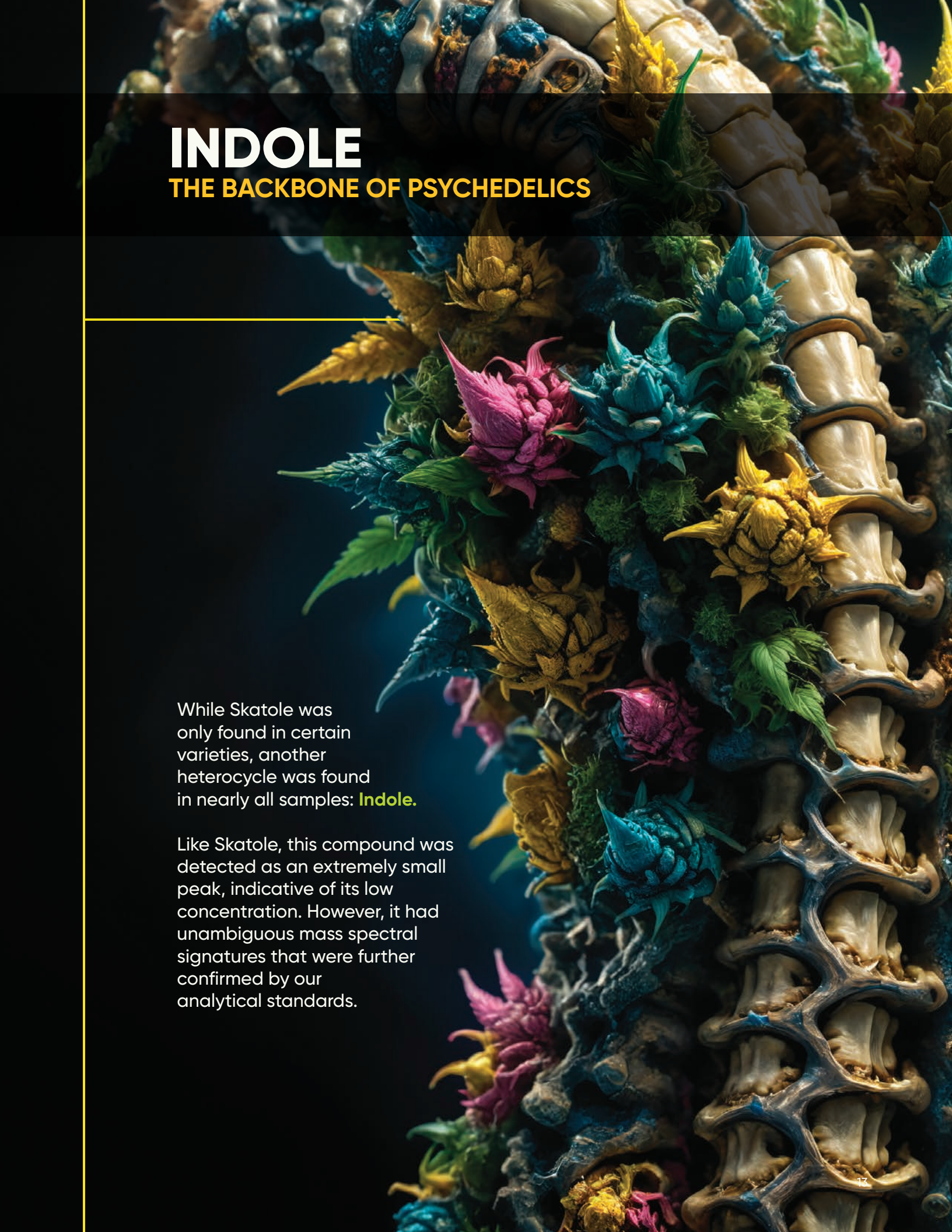
We note that Skatole's aroma is so powerful that once you smell it in its isolated form, diluted or not, you can never unsmell it.

It is truly like opening pandoras box, where once you identify this aroma in its pure form, **you can pick it up (for better or worse) seemingly everywhere** - from cannabis, to bad breath, to national park public restrooms.

As cannabis breeding evolves to emphasize **more exotic flavors and effects**, we expect to see cultivars with higher concentrations of Skatole emerge.

INDOLE

THE BACKBONE OF PSYCHEDELICS



While Skatole was only found in certain varieties, another heterocycle was found in nearly all samples: **Indole.**

Like Skatole, this compound was detected as an extremely small peak, indicative of its low concentration. However, it had unambiguous mass spectral signatures that were further confirmed by our analytical standards.

When isolated, Indole exudes a milder aroma than Skatole, though they share some aromatic characteristics. In its pure form, Indole carries a sharp, chemical, and ammoniacal fragrance. However, when diluted, **its scent undergoes a significant transformation**, often veering towards a distinct bottom-note floral essence at specific concentrations.

However, what may be most unique about Indole is how it interacts with the aroma of other compounds.

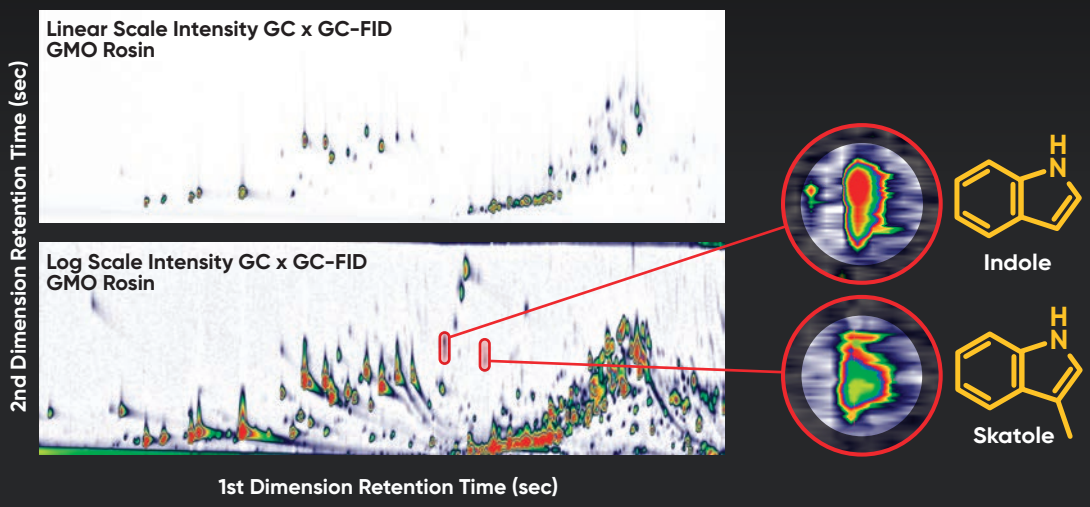


Figure 6. Two-dimensional chromatograms, adjusted with varying intensity scales, illustrate how minor compounds like Indole and Skatole can be easily overlooked.

Abstrax conducted tests internally on how Indole may modify the aroma of a combination of terpenes with other compounds. What was unexpectedly found was that Indole appears to lend to the funkiness found in many of the varieties described in the study. This result, combined with its ubiquity in cannabis, suggests that **it is most likely a key constituent in the quintessential aroma** produced by many cannabis varieties.

After experimenting in our lab, **it became evident that Indole has been a crucial missing piece** in the formulation of botanical terpene blends.

ONE DOOR CLOSES, THREE MORE OPEN

Just when we think that we've started to unravel the secrets of cannabis, she hits us with another mystery. **Skatole** and **Indole** are interesting for reasons far beyond just the aroma they each produce.

The Indole structure is the core structure of many biologically important compounds within plants, humans, and animals alike, as shown in **Figure 7.**

It is the key component of both tryptophan and melatonin, two important compounds found in the human body.

It is also the main functional group of psychedelic tryptamines such as psilocybin, dimethyltryptamine (DMT), and lysergic acid diethylamide (LSD).

The role of Indole in plant biochemistry is crucial due to its prevalence in numerous auxins, notably Indole-3-acetic acid. These auxins are pivotal plant hormones that help to regulate growth. Indole is also structurally akin to 3,3'-methylenedi(1H-Indole), colloquially known as DIM, a compound prevalent in cruciferous vegetables like broccoli and kale. The presence of Indole in these fundamental compounds underscores its significance in the intricate tapestry of plant development.

3,3'-methylenedi (1H-Indole) is particularly interesting because of its physiological properties: it's a weak CB1 and CB2 agonist and has shown activity against certain types of cancer.[3-5]

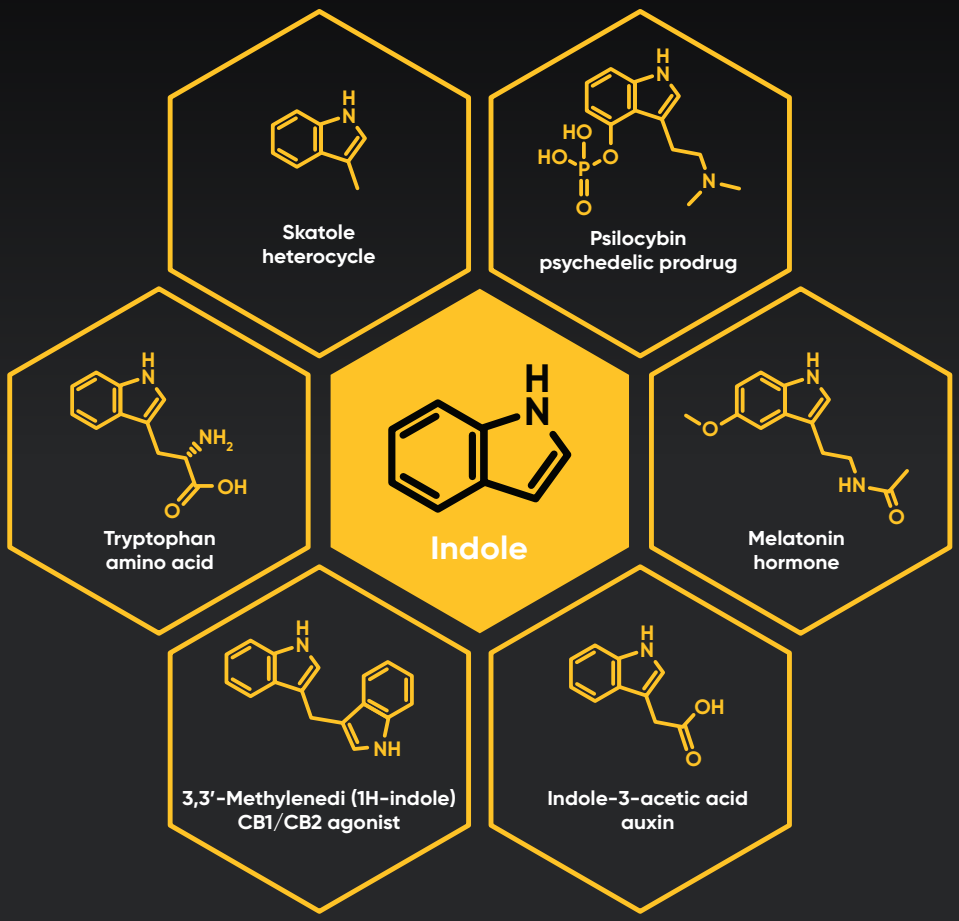
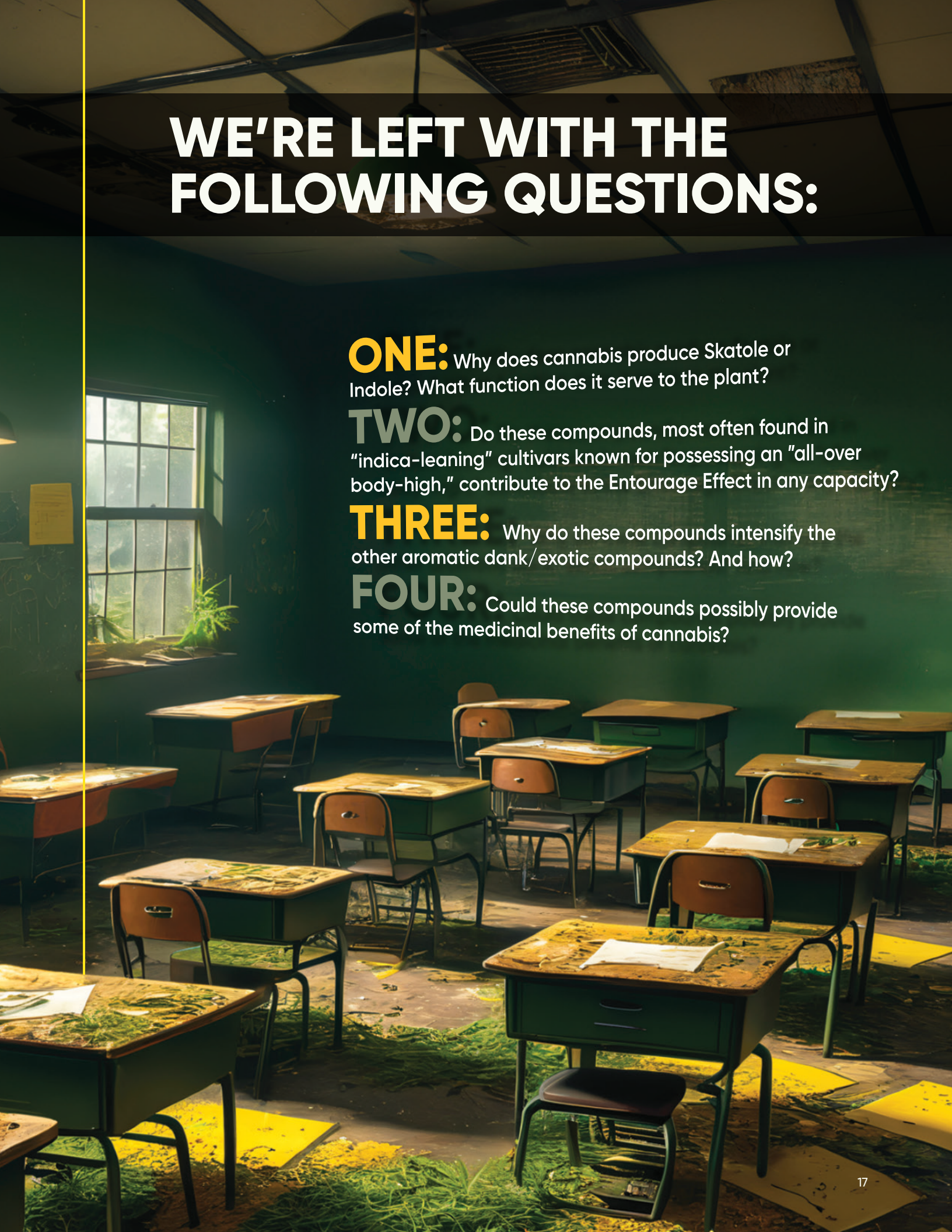


Figure 7. Schematic illustrating the relationship between Indole and many natural compounds found in nature.

Further research is needed to fully understand the importance of these compounds beyond the aroma of cannabis and their biosynthetic origin.

WE'RE LEFT WITH THE FOLLOWING QUESTIONS:



ONE: Why does cannabis produce Skatole or Indole? What function does it serve to the plant?

TWO: Do these compounds, most often found in "indica-leaning" cultivars known for possessing an "all-over body-high," contribute to the Entourage Effect in any capacity?

THREE: Why do these compounds intensify the other aromatic dank/exotic compounds? And how?

FOUR: Could these compounds possibly provide some of the medicinal benefits of cannabis?

CONCLUSION

We've unveiled the chemical origins behind some of **cannabis's most mysterious aromas**, namely the Chemical and Savory scents.

Our findings highlight Indole and Skatole as pivotal players in these aromatic profiles.

Indole imparts a distinct funkiness to numerous cannabis varieties, while Skatole is instrumental in crafting the potent chemical and savory nuances found in cultivars like 710 Chem and GMO. The uniqueness of these compounds lies in their chemical structures, setting them apart from other known secondary metabolites in cannabis. The intricate interplay between Indole and other significant natural compounds hints at the deeper complexities within cannabis. This suggests the potential discovery of other unforeseen compounds with similar roles upon further exploration — **a journey Abstrax is actively embarking on.**

If you'd like to experience **Skatole** and **Indole** in action, Abstrax Tech has created a new formulation of GMO based off of the rosin analyzed in this study. See for yourself what savory, exotic cannabis can be like.

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EPILOGUE

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- **The Science of Exotic I: The Dawn of Flavorants** – Learn why terpenes might not be the most effective method for discerning the aromas of cannabis.

- **The Science of Exotic III: Tangie** – Learn why certain cannabis varieties have intense, pungent citrus notes that seem to linger. Spoiler: it's not Limonene!

- **The Science of Exotic IV: Sweet** – Learn about all of the new chemistry in many of your favorite sweet, fruity, or dessert-like varieties.

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