

The Chemistry and Perception of Terpenes

By Avery Gilbert, Ph.D., Headspace Sensory, LLC

The aroma of cannabis flower is universally recognizable and is a central part of the cannabis experience. Yet there's an incredible range of odor character between varieties, rivaling that of coffee, tea, and wine. This diversity adds to the fun – and frustration – of making a purchase at the dispensary. Some people seek out the woody, herbal, earthy scent of OG Kush. Others prefer the pungent, sweet, citrus scent of Durban Poison.

Reduced to chemical terms, the cannabis aroma is created by the release of volatile molecules known as terpenes. Much attention has been given to the role of terpenes in modulating the cannabis “high” (the so-called entourage effect); terpenes are also credited with some mood-altering properties. [1,2] My interest is more basic: I want to find out how consumers perceive cultivar aromas and how this perception affects their purchase decisions and user experience.

My approach to cannabis aroma is that of a “smell scientist.” As a psychologist coming from a career in the fragrance industry with lots of experience in the sensory evaluation of scented

products, I know that small tweaks to a perfume formula can lead to major differences in consumer perception. My specialty is measuring these perceptions.

If cannabis scent is based on terpenes, can we describe a cultivar's aroma by listing its most abundant terpenes? Not really. There are a couple of reasons for this.

First, every aroma molecule has a unique concentration-intensity curve. The curve shows how perceived odor intensity increases with concentration. The elevation and slope of the curve vary dramatically from one molecule to the next. For example, a given concentration of molecule x may smell twice as strong as the same concentration of molecule y. And doubling the concentration of x may increase its perceived intensity by a factor of 10, while doubling the concentration of y may hardly change its intensity at all. There's a lesson here: an abundant terpene with low odor impact may not contribute much to a flower's aroma. Conversely, a trace amount of a high-impact molecule may have a huge effect.



There's a second reason why listing terpenes in order of abundance is no substitute for an aroma description: it's called mixture suppression (or non-additivity). Basically, a mixture of odor molecules creates an impression that is different from the sum of the individual ingredients smelled on their own. This is why a floral bouquet has its own distinctive scent, one that is not easily reduced to the smell of any one or two flowers in the bunch.

Here's the bottom line: it is extraordinarily difficult to extrapolate from a gas chromatograph output to a smell description. This is why perfumers spend years learning the smells of individual raw materials, as well as those of simple mixtures (called "accords") that are the building blocks of perfume.

So, what does all this mean when it comes to analyzing the smells of cannabis? It means we need to turn to quantitative sensory evaluation – the fancy name for sniff testing. This is what chemist Joseph DiVerdi, Ph.D., and I did in a study published in 2018. [3] It was the first time anyone had asked people to sniff samples of bud and rate them using a list of odor descriptors.

The results were clear: individual cultivars displayed distinctive aroma profiles. Among other things, we found that the traditional cannabis terms "skunk" and "diesel" are useful descriptors: our panelists selectively applied them to certain plants.

We also found that aroma profiles were arranged in two large clusters: one that smells pungent, sweet, and citrus (like Durban Poison) and another that smells woody, herbal, and earthy (like OG Kush). Dr. DiVerdi and I replicated this finding in a second paper in 2019. [4] It seems likely to me that there are two main categories of cannabis aroma, and all kinds of variation within them. My dream is to create a map that locates cultivars according to their aroma similarity. (Knowing what we know from earlier in this piece, a distantly related pair of cannabis plants might differ only by a tiny amount of a highly potent terpene!)

The biggest argument in favor of bringing sensory evaluation to the cannabis industry is a practical one. You need to know how your customers perceive your product and they're not going to tell you "that bud has too much beta-myrcene" or "that vape cartridge needs more alpha-pinene." They are going to use smell words just as we all do in everyday life. Giving consumers a standard lexicon to pick from helps everyone – cultivators, extractors, product designers, and retailers – assess the subjective by measurable olfactory impressions of the product.

Imagine how a sensory evaluation database could assist cannabis breeders. Rather than chase higher levels of delta-9-tetrahydrocannabinol (THC) or cannabidiol (CBD), they could chart a path toward hybrids with a desirable (and possibly novel!) aroma character.

Perhaps most important of all, a systematic program of sniff testing could reveal the sensory segmentation of the consumer market. This would let us link cultivar aroma preference to specific demographics, personal habits, and usage. Who prefers the funky, skunky types? How large of a market segment are they? How much more are they willing to pay for that type of cannabis? Do they believe it gives them a specific sort of "high"?

Knowing the precise chemical composition of terpenes is useful, but knowing how people respond to terpenes at the sensory level can teach us a lot about what consumers believe and how they approach and interact with cannabis products.

About the author

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