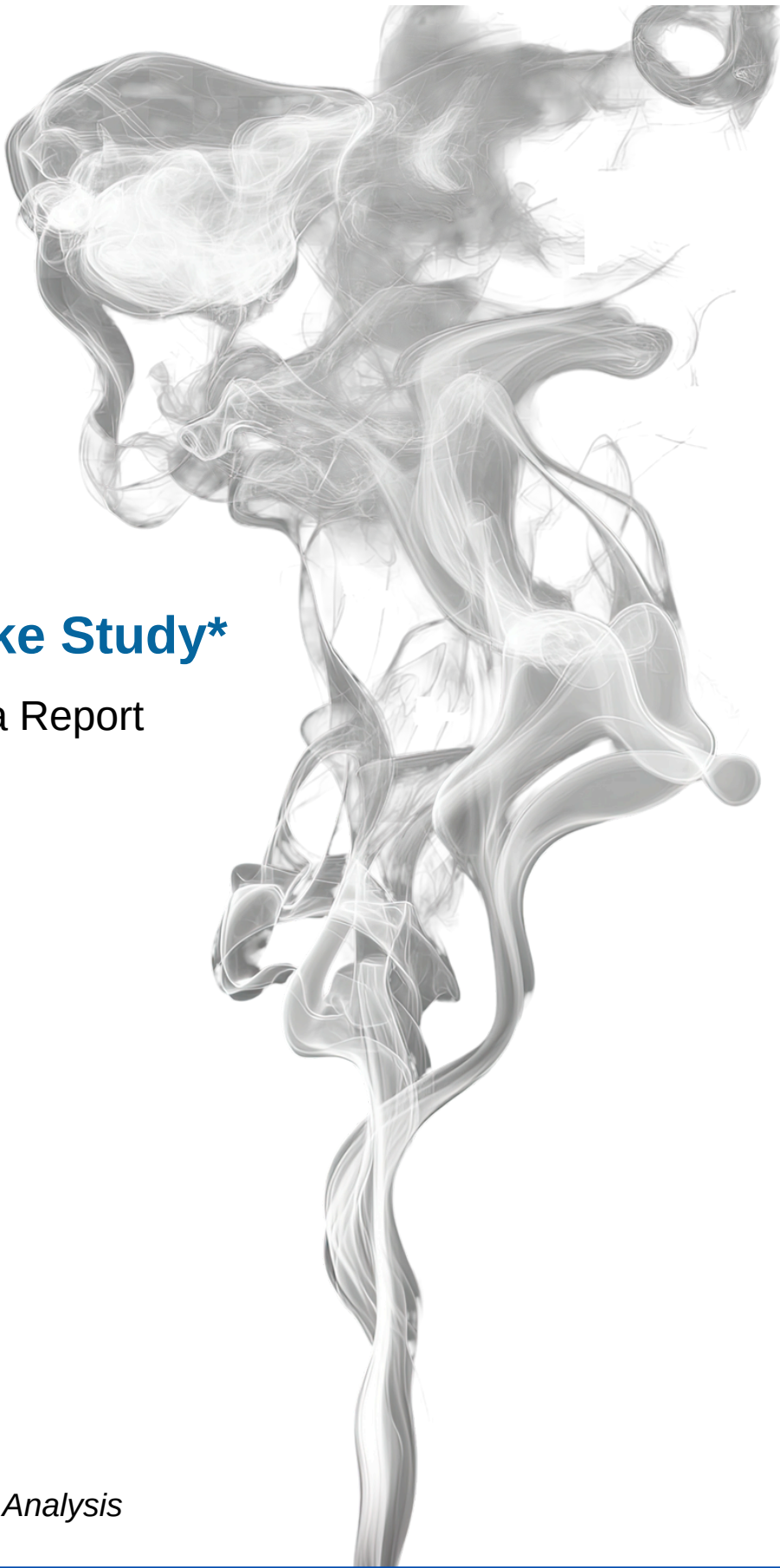




HBI Innovations Smoke Study*

Cones vs. Cylinders Data Report

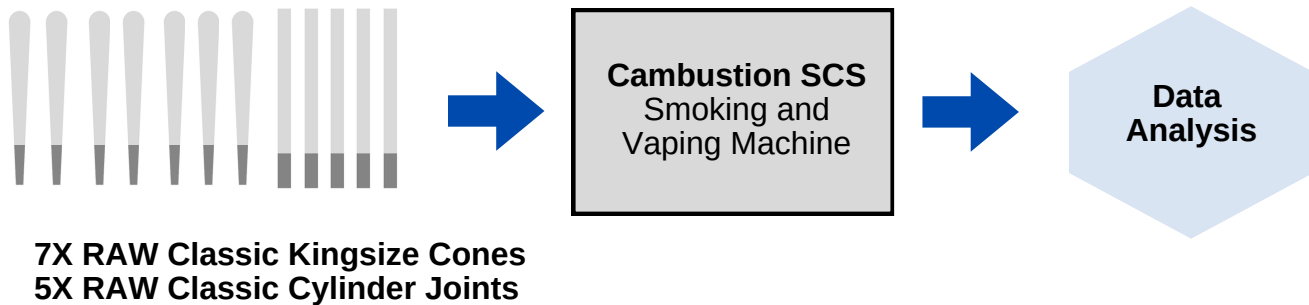
May 2026

**Preliminary Data Report, pending Ash Analysis*

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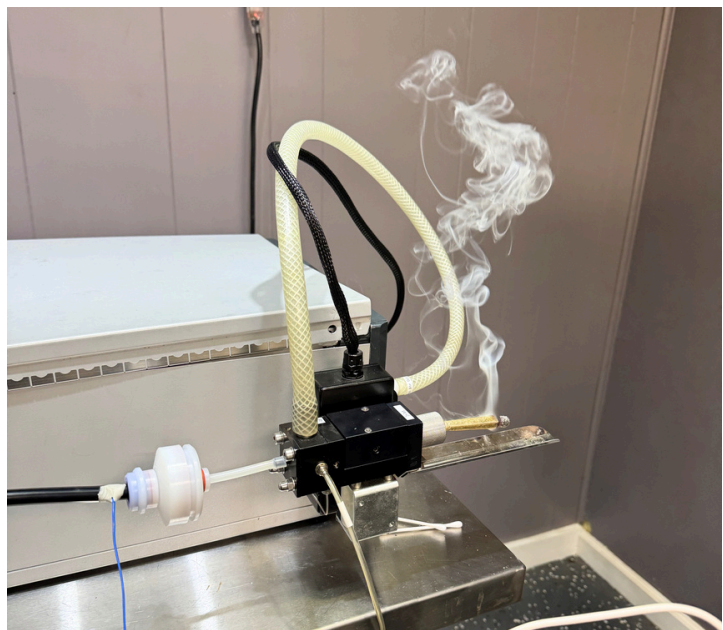
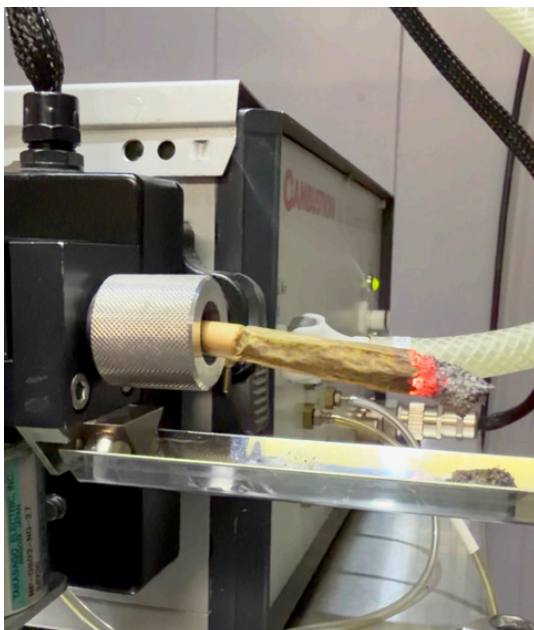
Background & Experimental Design



Smoke Research and Protocol Overview

Research on the smoke of *Cannabis sativa* has been limited by systemic barriers. Utilizing a standardized machine, such as the Cambustion SCS, creates more reproducible aerosols for the analysis of the cannabinoids, terpenes, and other molecules delivered in the smoke. While all previous scientific studies have relied upon programming the machine using standards optimized for tobacco and cigarette smoke, this experimental design used a novel puff topography profile developed directly from real-world data of cannabis consumers.

This study was designed to evaluate differences in smoke output between pre-packed cones and rolled, straight tube joints. Seven (7) packed cones and five (5) rolled joints were combusted using a Cambustion SCS smoke machine with particulate matter collected in-line on a Cambridge filter pad (compliant with ISO 3308:2000). Smoking characteristics such as total resin captured, roach weight, and puff count to completion were recorded, and collected filter pads were analyzed for cannabinoid and terpenes.



Dimensional & Material Properties of Samples

Flower from the 'Peaches and Cream' strain was ground and sifted in a 2 x 2 mm metal mesh screen to remove stems prior to weighing for sample preparation. Because the flower material was sticky, clumps were manually broken apart before filling. Each sample contained a total of 1 g of flower material.

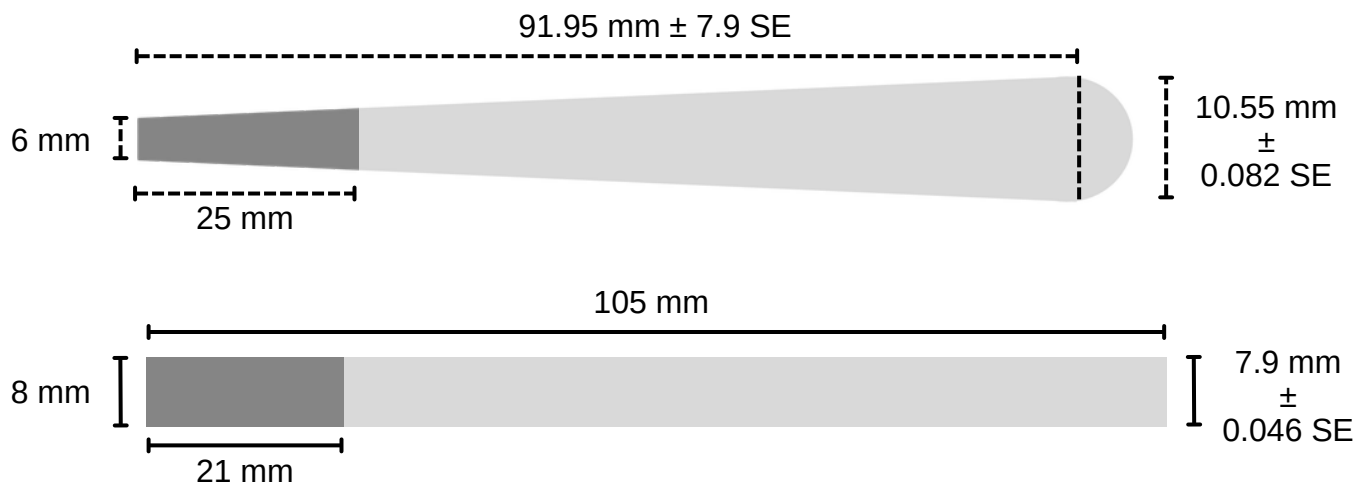
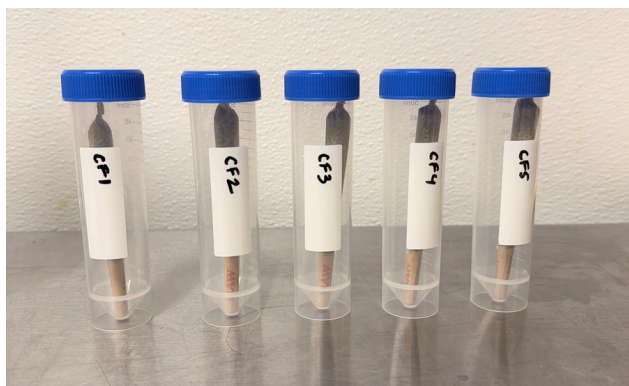
RAW Classic Kingsize Cones were filled with the prepared material by first adding approximately 100 mg to the base of the cone. The cone was then tamped using a thin glass rod to settle and partially compact the material. Additional material was added by rotating the cone while scooping material directly from the weighing paper, and the cone was gently tapped on the table throughout filling to promote consistent settling and uniform packing. Once filled, the end of the cone was twisted closed, and the thin glass rod was used, if necessary, to gently compress material near the end of the cone.

RAW Classic 5M rolling paper was cut into 105 mm length sections. Prior to filling, clumps of flower material were manually broken apart. A RAW Kingsize rolling machine fitted with a RAW Wide Tip at one end was filled with the prepared material, which was evenly distributed along the length of the machine. Approximately 500 mg of material was initially added and lightly compacted along the length before the remaining material was added and gently pressed into place. The rolling machine was then closed, and the rolling paper was immediately inserted into the roller. The adhesive strip was activated once the paper reached the end of the roll, and after one full rotation marked by the RAW logo, the finished rolled joint was removed and measured.

Sample Measurements:

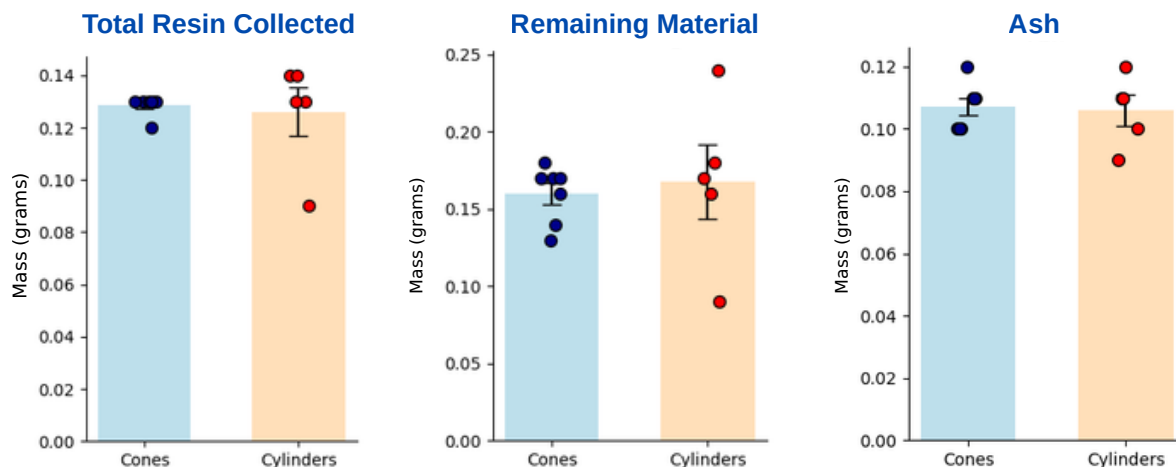
Weight of Flower in Samples:

1.009 g $\pm$ 0.0016 SE



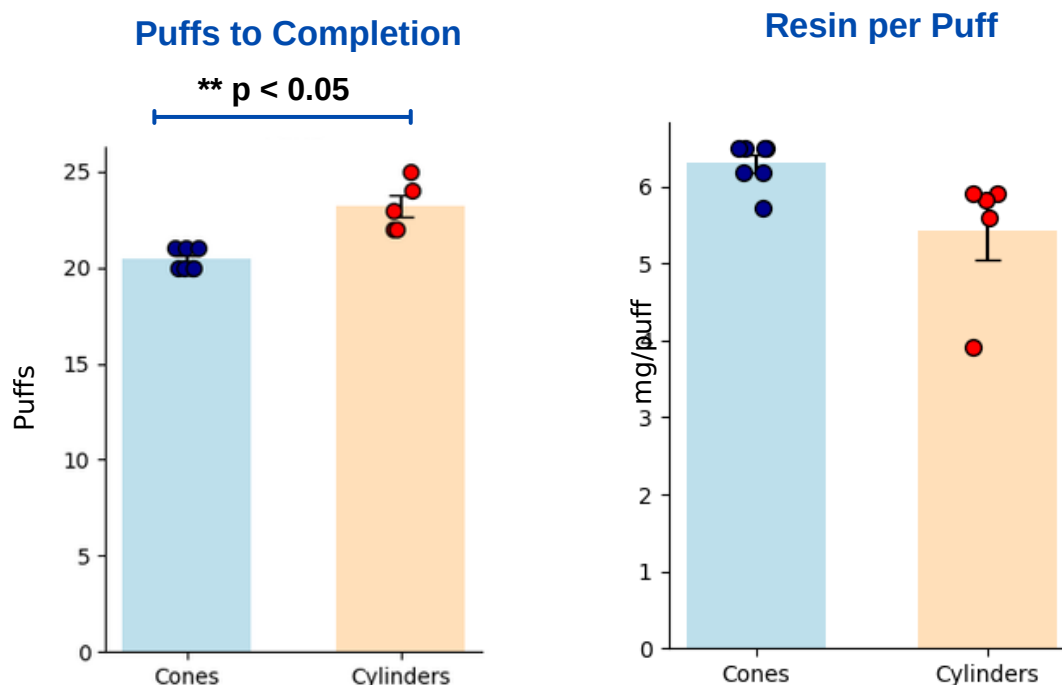
Burn Characteristics & Per Puff Efficiency

There were no significant differences observed between the total resin weight collected on the filter pads, the remaining flower material in the roach, or the weight of the ash generated.



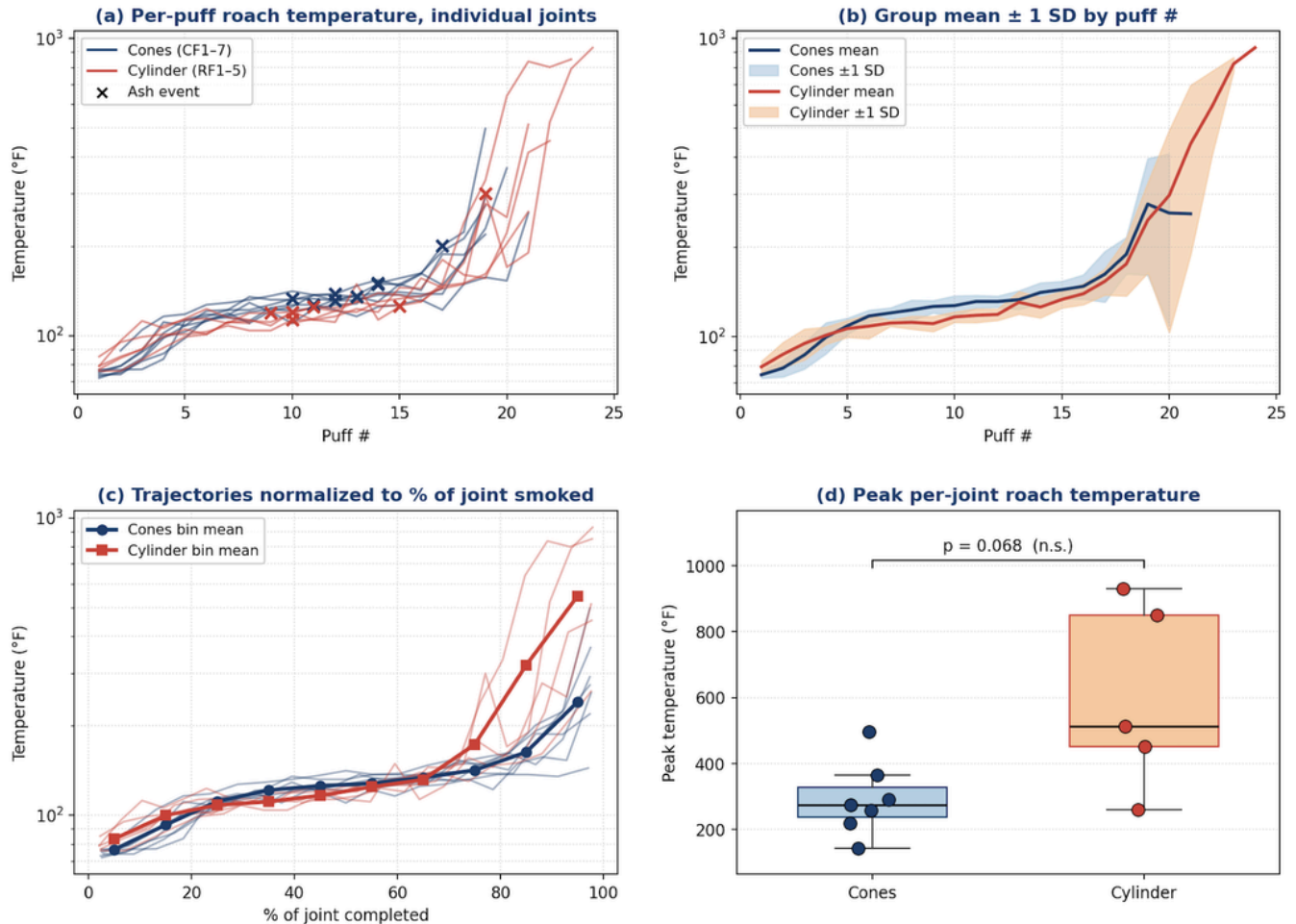
However, there was a statistically significant difference observed in the number of puffs needed to reach completion between the cones and the straight rolled samples. The cone samples reached completion after an average of 20.4 ± 0.53 puffs while the straight rolled samples reached completion after an average of 23.2 ± 1.29 puffs.

When the mass of smoke resin collected was normalized to the average number of total puffs to completion for each sample group, there was a difference observed. The cones samples averaged 6.30 ± 0.30 mg/puff delivered while the rolled samples averaged 5.43 ± 0.86 mg/puff, however, the p value did not clear $p < 0.05$ for significance.



Burn Characteristics & Per Puff Efficiency

Per-puff roach temperature — Cones vs Cylinder



Temperature at the roach of the joints were measured for each puff for both cones and cylinder joints. Both formats showed similar qualitative behavior during the combustion process showing a slow rise from baseline, a plateau through the middle of the smoke, and a sharp ramp during the final puffs. Cylinder joints trended towards higher peak roach temperatures compared to cones ($p = 0.068$) and required more puffs to complete.

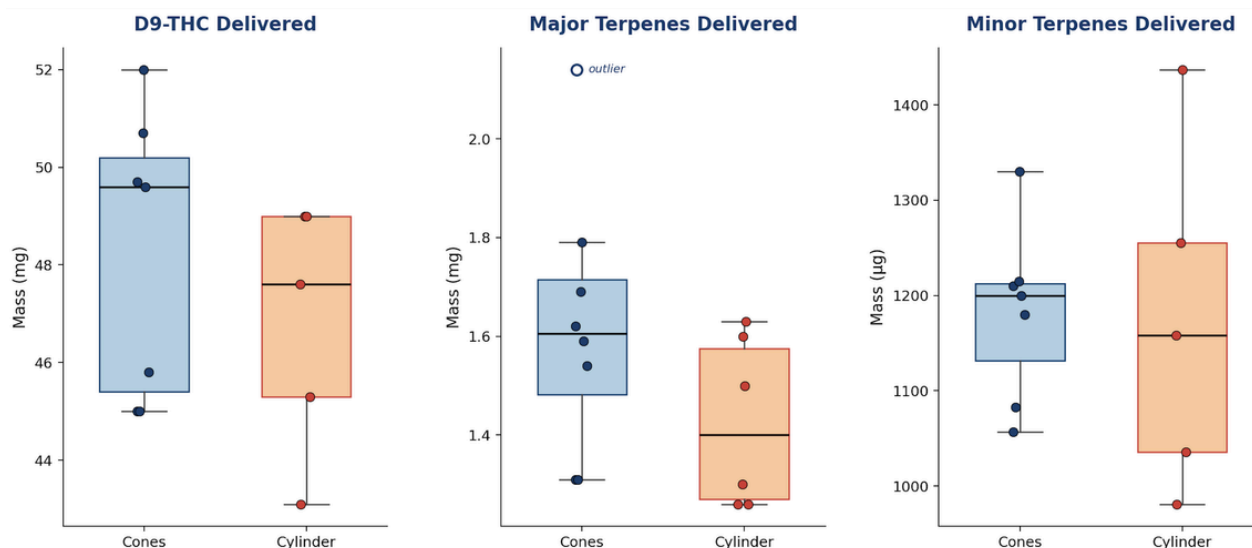
During the middle of the joint, cones ran modestly hotter on a per puff basis and held their ash column to a significantly higher temperature before the first ash (138 °F vs. 121 °F; $p = 0.002$). The peak-temperature trend supports the argument that cones reduce the temperature of smoke entering the lungs but does not clear $p < 0.05$.

Cannabinoid & Terpene Delivery

The total mainstream delivery was analyzed for THC, CBN, major terpenes and minor terpenes. There were no statistically significant differences observed between the total mass of THC, major terpenes or minor terpenes captured on the filter pad.

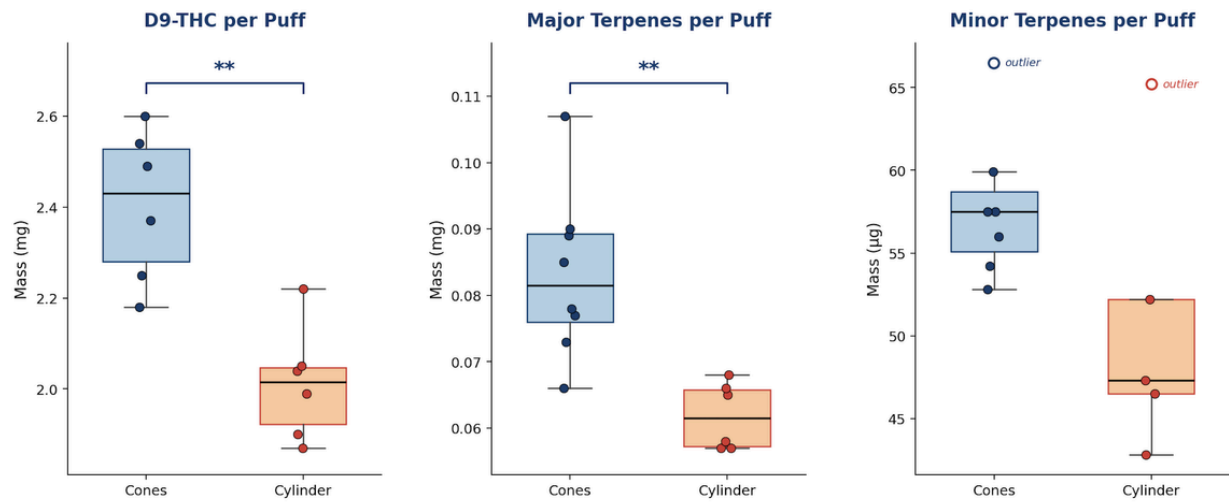
Cones delivered 48.96 mg of THC per joint vs. 46.83 mg for cylinder joints ($p = 0.43$), 1.67 mg vs. 1.46 mg major terpenes ($p = 0.18$), and 1,182 μg vs. 1,174 μg minor terpenes ($p = 0.93$). CBN was modestly higher in cones (0.46 mg vs. 0.40 mg, $p = 0.028$).

The flower used in this experiment for both the cones and the cylinder joints was the strain Peaches and Cream and was analyzed in triplicate. It contained 0.59% THC and 16.25% THCA giving the total potential THC content of 14.85% (Dussy et al., 2005). This amounts to 148.5 mg of THC per 1 gram joint after complete decarboxylation. The transfer efficiency from flower to filter pad was 32.97% for cones and 31.54% for rolled. This is consistent with the ~29% transfer efficiency calculable from the data reported by Pomahacova et al. (2009) for machine-smoked cannabis cigarettes and previous work by Van der Kooy (2008).



When the total mass of each tested compound was normalized to the puff count of each individual joint, a statistically significant per puff average was observed. The cones delivered **2.40 mg** of THC per puff compared to **2.02 mg** for the rolled samples ($p = 0.0015$), and 0.082 mg of major terpenes per puff compared to 0.063 mg for the cylinder samples ($p = 0.009$). A similar trend was also observed for minor terpenes (57.88 $\mu\text{g/puff}$ vs. 50.76 $\mu\text{g/puff}$), although this did not reach statistical significance ($p = 0.15$).

These results indicate that the difference between the two formats lies in the **density of each inhalation** rather than the total cannabinoid or terpene yield from the flower. Cone samples delivered an equivalent dose to rolled samples while requiring ~12% fewer puffs to reach completion.



Ash Analysis

Pending Data

Conclusions

The aim of this study was to evaluate the efficiency and delivery of cannabinoids and terpenes in cannabis flower when smoked in a pre-formed cone vs. a straight cylinder roll. Across burn characteristics and cannabinoid and terpene delivery the two formats produced statistically similar total yields. However, these two methods diverged significantly on how the total yield of active compounds was distributed across each puff and how consistently those values were reproduced from one joint to the next.

Cones reached completion in fewer puffs and delivered more total resin per puff; delivering 2.40 mg of THC per puff versus 2.02 mg for cylinder joints ($p = 0.0015$), and 0.082 mg of major terpenes per puff versus 0.063 mg ($p = 0.009$), and minor terpenes trending in the same direction. CBN was modestly elevated in cones compared to cylinder rolled joints which points to slightly higher peak combustion temperatures consistent with the larger per puff load. The total THC delivered, major and minor terpenes delivered, transfer efficiency, remaining flower in the roach, and total ash mass were all statistically indistinguishable between the two formats.

The observed per puff differences are likely attributed to the differences in geometry and diameter of the two joints. A RAW Classic Kingsize Cone was measured at 10.55 mm in diameter at the lit end whereas the cylinder joints were measured at 7.9 mm; this amounts to a 78% larger combustion cross section at the start of the smoke. The larger burning surface aerosolizes more material per draw, which translates directly into the higher per puff cannabinoid and terpene delivered observed, and the shorter puff count needed to finish smoking the joint.

There was a marked reduction in variability for cones across nearly every measured variable. The coefficient of variation ($CV = SD/Mean$) for total resin collected was 2.9% in cones versus 16.5% in cylinder joints, providing a 5.6 fold tighter distribution. Other factors like THC concentration, CBN levels, and minor terpene delivery and exposure were also over 2x tighter in cones vs cylinder joints.

Overall, these data represent multiple practical consequences for the consumer; a cone delivers a more predictable experience compared to cylinder joints with the same flower. While the total payload of cannabinoids and terpenes is nearly the same across formats, cones delivered a larger dose of active ingredients such as THC and terpenes per puff compared to cylinder straight joints. This may have practical implications for consumers as it will take fewer puffs of the joint to reach the desired level of medication.

Technical Details and Acknowledgments

The Cambustion SCS was operated with standard procedures including initial calibration and frequent cleaning. To clean the machine, the smoke collection compartment was fully disassembled, thoroughly cleaned with 99% isopropyl alcohol, dried, and reassembled. A calibration was performed after each cleaning. The *Cannabis sativa* specific puff topography profile that was utilized had a maximum flow rate of 41.7 mL/s with a measured total puff volume of 59.31 mL.

Data processing, analysis, and visualization were performed in Python using the pandas, NumPy, Matplotlib, and SciPy libraries. Samples were grouped based on sample name identifiers (i.e. “CF” for cones and “RF” for rolled), and all numeric variables were analyzed independently. Visualization included “jitter” in the data points to improve visibility of overlapping values. Welch’s two-sample t-test was used to gauge statistical significance, with significance set at a p value < 0.05.

This study was performed with contributions from: Dr. Allison Justice, PhD contributed to sample preparation and data generation, Dr. Miyabe Shields, PhD contributed to sample preparation, data generation, data analysis, and data report drafting and editing, Dr. Riley Kirk, PhD contributed to sample preparation, data generation, data analysis, data report drafting and editing, and overall project oversight, and Twinkle Paryani contributed to sample preparation and data generation. We also thank the members of Gobi Labs, Rachel Bard and Jack Weber, for their support and collaboration with data generation.

Citations

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