

# Quantitative Sensory Description of Strain-specific Cannabis Aroma Profiles

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## Introduction

- “Marijuana’s bad, and it also has a very distinct smell, m’kay?” (Mackey, 1998)
- The aroma character of dried flower varies markedly across different strains of *Cannabis* (Gilbert & DiVerdi, 2018)
- Consumer perception of product quality (potency, price, and interest in smoking) varies with strain-specific aroma
- Lexicons exist for wine (Noble, et al. 1987), coffee (World Coffee Research 2016) and beer (Strong & England 2015)
- An empirically-based olfactory lexicon for cannabis would benefit consumer, growers, and retailers
- Gilbert & DiVerdi (2018) had observers sniff and rate samples using a check-all-that-apply (CATA) ballot
- Here we extend those findings using quantitative sensory rating scales



## Objectives

- Use quantitative ratings scales to characterize the aroma profiles of multiple cannabis strains
- Compare results to those obtained by Gilbert & DiVerdi (2018) using CATA ballots

## Methods

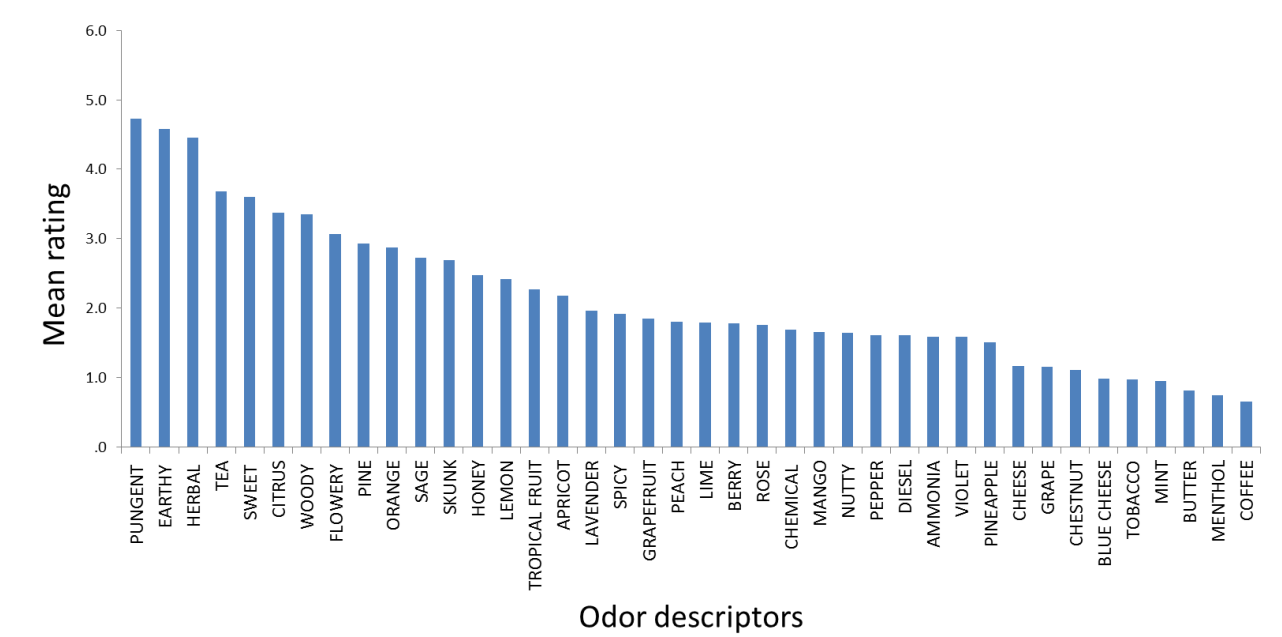
- Cannabis purchased at local dispensaries licensed for retail recreational sale in Colorado (Solace Meds, Infinite Wellness Center, Organic Alternatives)
- Ten strains tested: Blueberry, G13, Golden Goat, Hemlock, Jack Flash, Jilly Bean, Lamb’s Breath, Master Kush, Sour Diesel, and Tahoe Alien
- Each stimulus (1 g dried cannabis flower) presented in wide mouth 118 ml (4 oz) amber glass bottle labeled with a three-digit code. Samples stored at -2° C, thawed at room temperature 2 hours prior to testing
- Fifty-two people tested (26 ♂, 26 ♀; mean age 28.5 ± 7.4 years). All 21+ years old, Colorado residents, self-reported normal sense of smell. Paid \$20

- Forty odor descriptors selected from the 48 used by Gilbert & DiVerdi (2018)
- Apple, blueberry, pear, plum, strawberry, tar, tree fruit, and vanilla eliminated due to low frequency of endorsement and random assignment across strains
- Eleven-point scales (0 = “not at all x”; 10 = “extremely like x”) presented on a touch-screen device (Apple iPad)

## Results

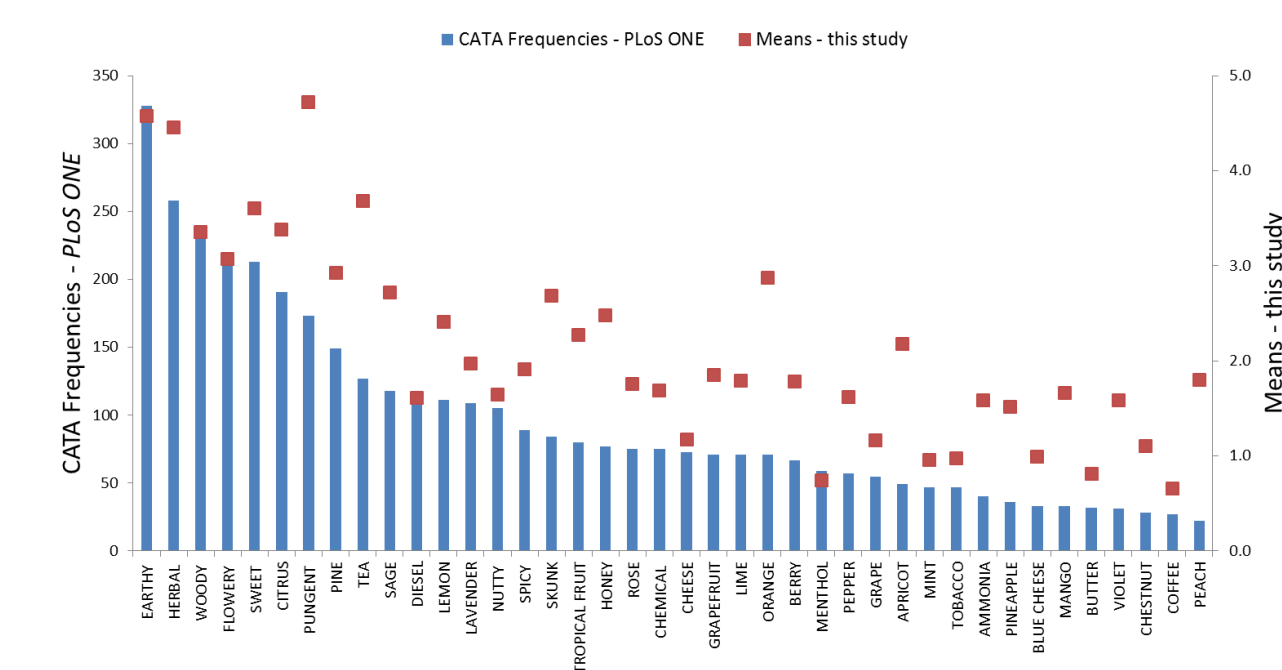
- Most participants had purchased (94.2%) and used (92.3%) marijuana since it became legal on January 1, 2014
- 17 subjects (32.7%) took part in the original CATA study

Figure 1. Mean ratings across all 10 cannabis samples



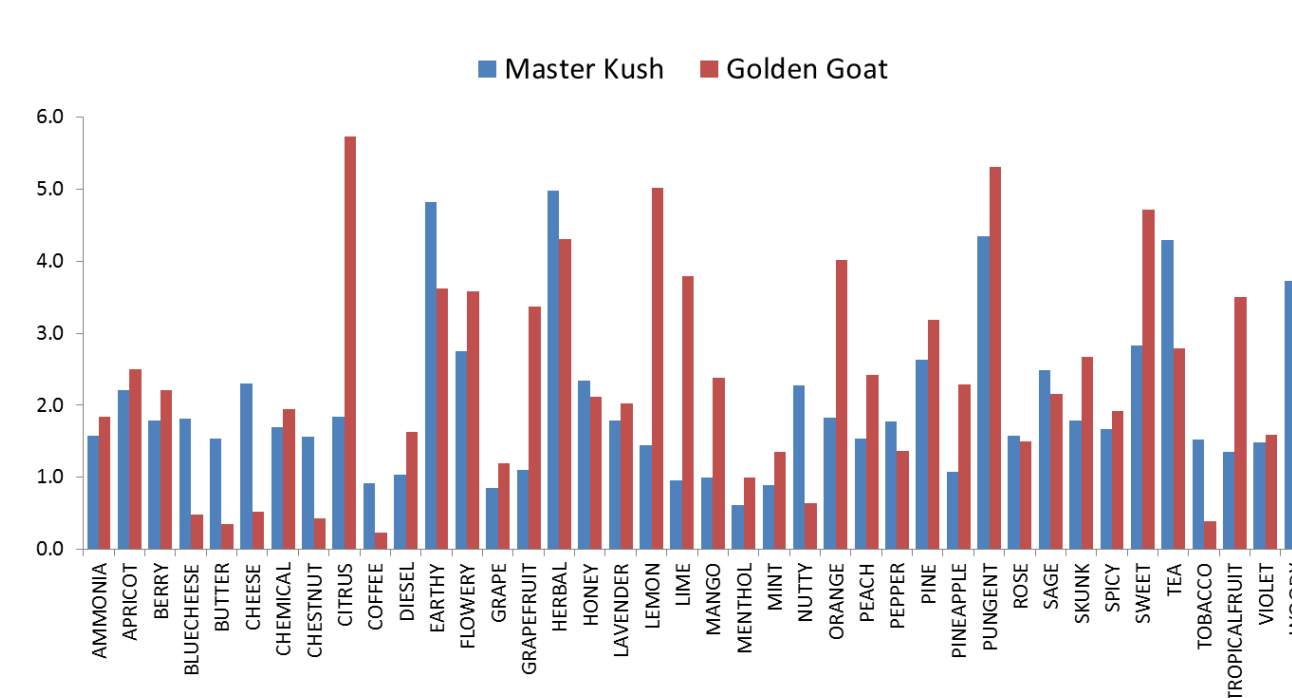
- Mean descriptor ratings ranged from 4.6 (Pungent) to 1.8 (Peach) (Fig 1)
- Across all samples, participants gave non-zero ratings to 22.7 ± 8.5 descriptors (vs 5.2 ± 2.8 in original study)
- Individual participants used an average of 9.5 to 39.3 descriptors across samples (vs 1.9 to 11.8 in original study)

Figure 2. Comparison with CATA results



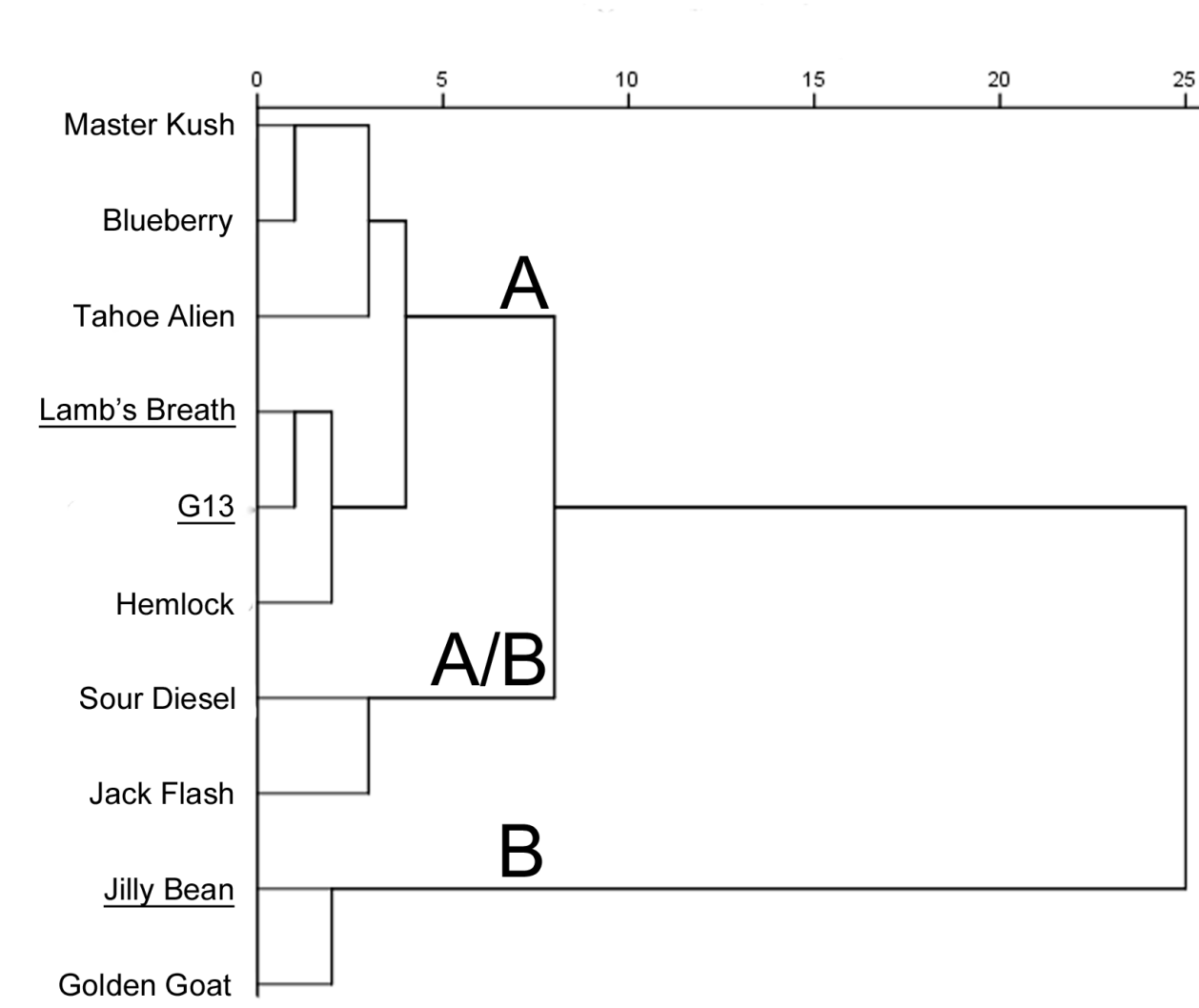
- Descriptor means tended to track endorsement frequencies from the original study (Fig 2)
- Despite different cannabis strains as stimuli, descriptor use with each method appeared to converge

Figure 3: Aroma profiles of two strains compared



- There was wide variation in strain-specific aroma profiles (Fig 3)
- Master Kush was characterized as Earthy, Herbal, Pungent, Tea, and Woody
- It also had distinctive notes of Cheese, Blue cheese, Butter, Chestnut, Nutty, Tea, and Tobacco
- Golden Goat was described as Citrus, Lemon, Pungent, Sweet, Herbal, Lime and Orange
- It also had notes of Mango, Peach, and Tropical Fruit

Figure 4. Hierarchical cluster analysis of the 10 cannabis strains

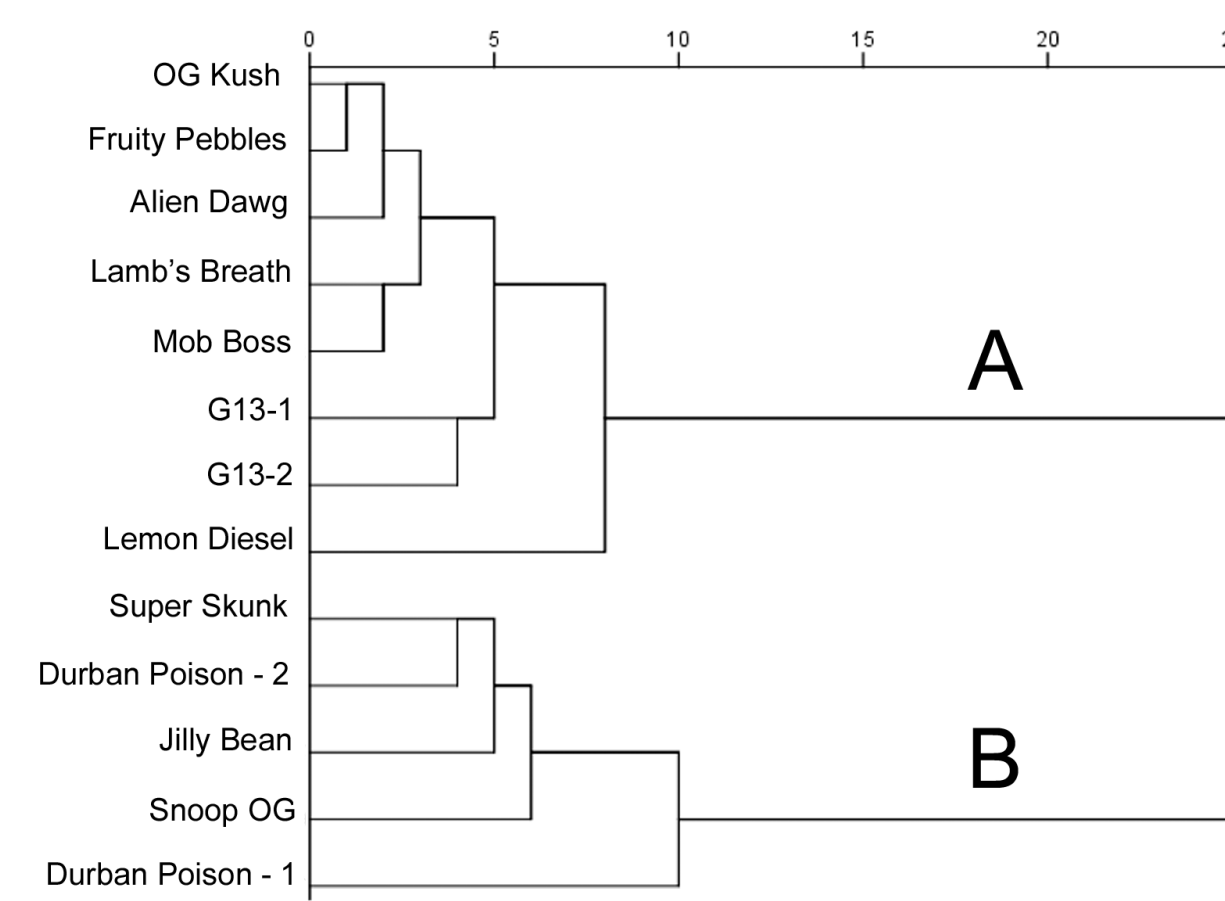


- Cluster analysis (Fig 4) produced a solution with two main groups (Clusters A and B) and a possible intermediate group (A/B)
- The Lamb’s Breath, G13, and Jilly Bean strains were also tested in the original study (Fig 5)
- In both studies, Lamb’s Breath and G13 sorted into one group and Jilly Bean into the other

Table 1. Five highest scoring descriptors for each strain

Cluster A					A/B		Cluster B		
Master Kush	Blueberry	Tahoe Alien	Lamb’s Breath	G13	Hemlock	Sour Diesel	Jack Flash	Jilly Bean	Golden Goat
herbal	earthy	earthy	earthy	earthy	earthy	pungent	pungent	pungent	citrus
earthy	pungent	pungent	herbal	tea	herbal	earthy	herbal	citrus	pungent
pungent	herbal	woody	tea	herbal	pungent	herbal	earthy	orange	lemon
tea	woody	herbal	pungent	pungent	sweet	citrus	citrus	sweet	sweet
woody	tea	tea	woody	sweet	tea	skunk	tea	herbal	herbal

Figure 5. Hierarchical cluster analysis of the 13 cannabis samples from Gilbert & DiVerdi (2018)



- Clusters A and B (Fig 4) have distinctive aroma profiles based on top rated descriptors for their respective strains (Table 1)
  - Cluster A is predominantly Earthy/Herbal/Pungent/Woody
  - Cluster B is predominantly Citrus/Pungent/Sweet

- Each corresponds to a similarly characterized cluster in the original study (Fig 5)

- An intermediate grouping (Cluster A/B in Fig 4) consisting of Sour Diesel and Jack Flash shares descriptors with the two basic clusters

- Compared to the original study, there is a consistent pattern of results, even though
  - The original study used CATA ballots and this study used numerical rating scales
  - There were only 3 strains in common among the odor stimuli

## Conclusions

- The Earthy/Herbal/Pungent/Woody and Citrus/Pungent/Sweet aroma profiles are confirmed
- These profiles represent a basic divide in the dried cannabis flower odor space
- An intermediate aroma profile may also exist
- Quantitative rating scale results and CATA ballots produce similar results
- Participants tend to endorse more odor descriptors when using rating scales
- A reduced set of 40 descriptors is adequate to specify cannabis aroma
- Skunk and Diesel are valid descriptors
- Strain-specific aroma profiles are potentially useful in quality control, plant breeding, identification of consumer preferences, and development of ancillary products

## References

1. Mackey *South Park* 1998; 2:4
2. Gilbert & DiVerdi *PLoS ONE* 2018; 13(2):e0192247
3. Noble et al. *Am J Enol Vitic* 1987; 38:143
4. World Coffee Research Sensory Lexicon 2016; ISBN 978-0-9971542-0-7
5. Strong & England 2015; Style Guidelines: Beer Style Guidelines. Beer Judge Certification Program.

## Ethics Statement

This study was approved by the Western Institutional Review Board (Puyallup, WA) (WIRB Protocol #20170080). All participants provided informed written consent. At no time did participants come into direct contact with cannabis samples. Retail sale of marijuana for recreational use to adults 21 years of age and older has been legal in the state of Colorado since January 1, 2014.

## Acknowledgements

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