

# **Tasting Terroir - Aroma and Flavor Sensory Analysis of Malted Barley for Craft Brewing and Distilling in WA**

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**Food Systems**

WASHINGTON STATE UNIVERSITY

**In Partnership with:**

**WSU Sustainable Seed Systems Laboratory**

**WSU Viticulture and Enology Program**

American Association of Geographers  
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Washington, DC



# Overview of Workshop

Introduction to Flavor Analysis

Hot Steep Methodology

WSU Barley Research

Perform Sensory Analysis

Review Results



# Introduction – Flavor Analysis

Two main approaches:

- **Instrumental techniques**

- Chromatography (LC, GC, CE) to separate flavor compounds, followed by detection (FID, UV-Vis, MS)
- May require extraction step
- Alternative techniques such as GC-Olfactometry
- “E-tongue” and “E-nose”
- Useful for quantification

- **Sensory analysis**

- Use of human subjects to determine characteristics, flavor differences in a product, or consumer preferences
- More applicable to real-world



# Introduction – Why Sensory?

- Instrumental techniques have limitations
  - People have threshold limits
  - People have difference thresholds
  - Mixtures of flavor compounds harder to evaluate
- Consumer preference insight
- Perception is complicated



# The Senses

Overall flavor is influenced by all of the five main senses

- Sound
- Sight
- Feel
- Taste
- Aroma



# The Senses – Sound

- Important in food sample analysis
- Less of a focus in beverage analysis
  - Can be useful for carbonated beverages
  - Ambient noise can have an effect on sensory perception<sup>1</sup>

<sup>1</sup>Spence, C. *Physiol. Behav.* 2012, 107 (4), 505–515.



# The Senses – Sight

- “First taste is with the eyes”
- Color has an influence on taste
  - Red/Orange = “Sweet”, Green/Yellow = “Sour” for same beverage dyed different colors<sup>2</sup>
- Color has an influence on flavor descriptors
  - White wines dyed red were described with typical red wine descriptors<sup>3</sup>

<sup>2</sup>Spence, C.; Levitan, C. A.; Shankar, M. U.; Zampini, M. *Chemosens. Percept.* **2010**, 3 (1), 68–84.

<sup>3</sup>Morrot, G.; Brochet, F.; Dubourdieu, D. *Brain Lang.* **2001**, 79 (2), 309–320.



# The Senses – Feel

- In beverage analysis, typically related to trigeminal nerve sensation
  - Referred to as “mouthfeel”
  - Responsible for “astringent”/“drying”, “cooling”, “hot”, “spicy”
  - Lingering effects





# The Senses – Taste

- Specific reactions with taste receptors on tongue
- Individual receptors responsible for the five main tastes (possibly more):
  - Bitter
  - Sweet
  - Sour
  - Salty
  - Savory (Umami)
  - Prospective tastes: fat<sup>4</sup>, starch<sup>5</sup>, calcium<sup>6</sup>
- There is no “tongue map” or “taste regions”
  - Based on poor translation of German paper<sup>7</sup>

<sup>4</sup>Besnard, P.; Passilly-Degrace, P.; Khan, N. A. *Physiol. Rev.* **2016**, 96(1), 151–176.

<sup>5</sup>Lapis, T. J.; Penner, M. H.; Lim, J. *Chem. Senses* **2016**, 41 (9), 755–762.

<sup>6</sup>Tordoff, M. G.; Alarcón, L. K.; Valmeki, S.; Jiang, P. *Scientific Reports* **2012**, 2(1).

<sup>7</sup>Hänig, D.P.; *Philos. Stud.* **1901**, 17, 576-623.



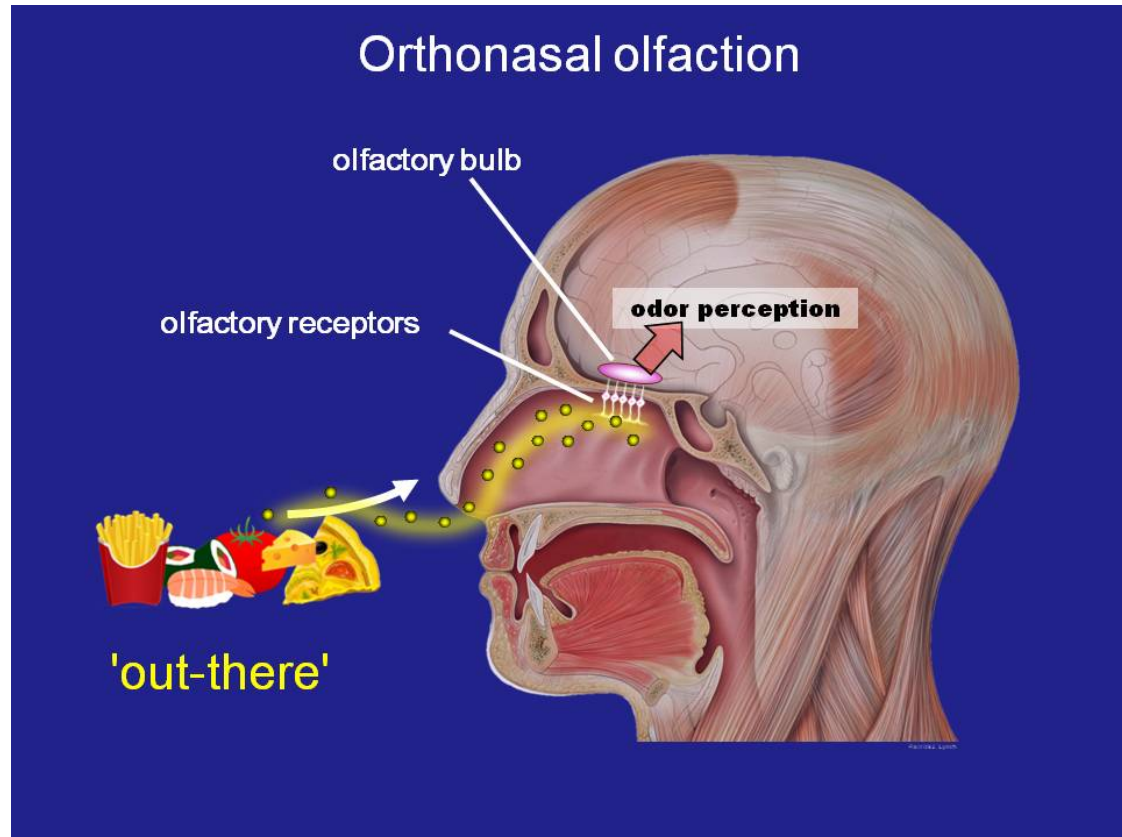
# The Senses – Aroma

- Based on olfactory response to volatile chemical compounds
- Focus of barley trial sensory panel
- Complicated
  - Ratios of compounds change overall aroma
- Strong ties to memory
  - Influences descriptors for aromas
  - e.g. “TCA” (cork taint) smells like “moldy basement”
- Happens in two phases
  - Orthonasal
  - Retronasal



# The Senses – Aroma

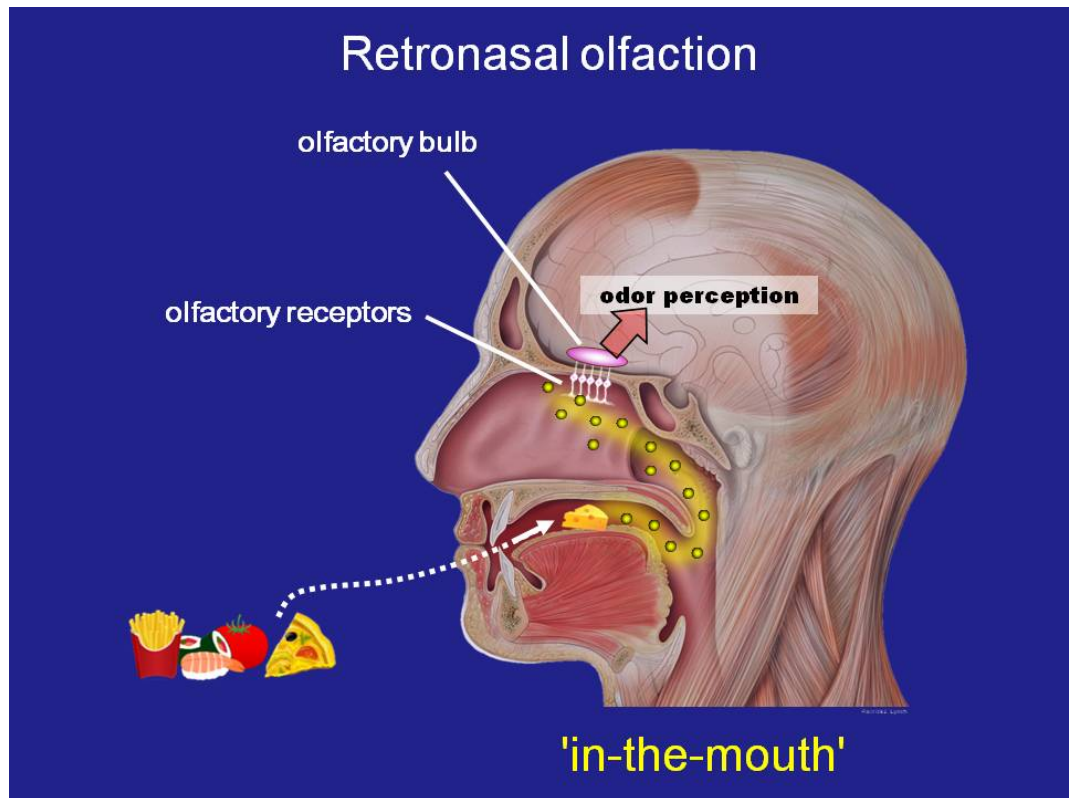
- Orthonasal olfaction
  - Before food or beverage enters mouth
  - Chemical compounds reach receptors in olfactory bulb
  - Signal sent to brain
  - Some compounds can be detected in parts per quadrillion
    - Depends on matrix





# The Senses – Aroma

- Retronasal olfaction
  - Occurs inside mouth
  - Body heat helps volatilize compounds
  - Salivary enzymes cleave bound aroma compounds
  - Enhanced by aeration



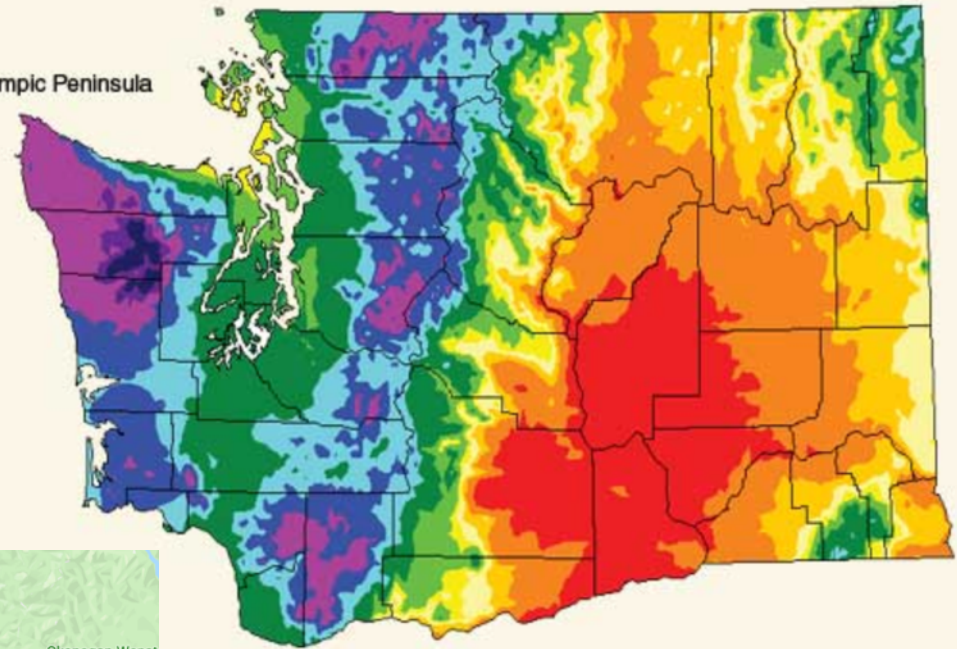


# **The WSU Barley Trials**

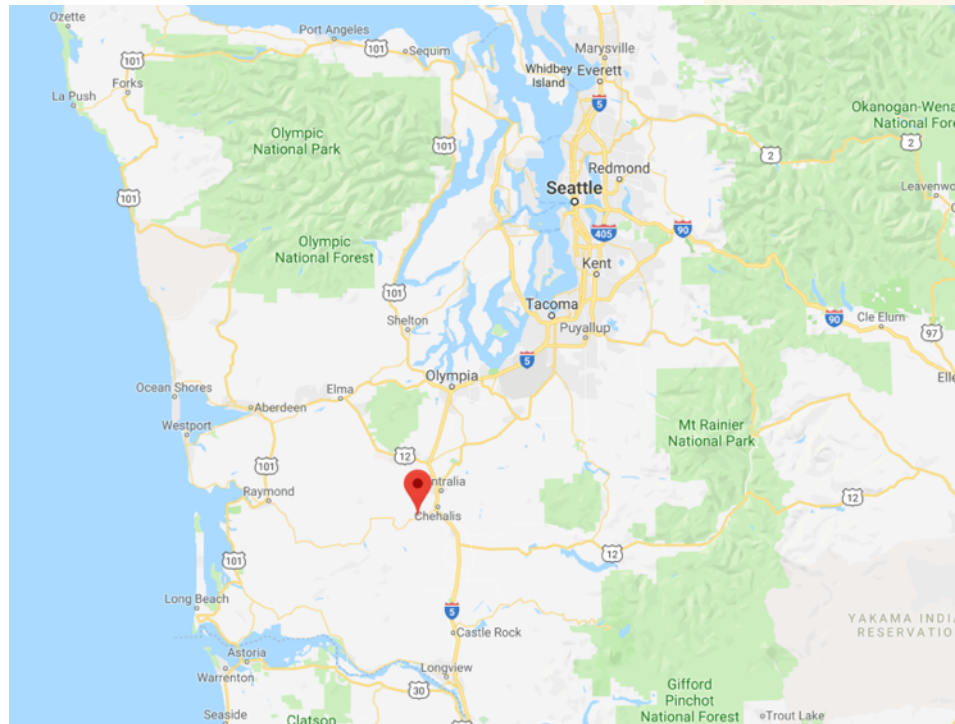
Searching for beer and whiskey-worthy strains to grow west of Cascades

# Map of WA and South Puget Sound

Olympic Peninsula



<https://content.lib.washington.edu/cmpweb/resources/map-rainfall.html>



**Legend (inches per year)**

	Less than 10		40 to 60
	10 to 15		60 to 80
	15 to 20		80 to 100
	20 to 25		100 to 140
	25 to 30		140 to 180
	30 to 40		More than 180

<https://www.google.com/maps/place/Adna,+WA+98532/@47.102669,-123.6625371,8.11z/data=!4m5!3m4!1s0x5493e13288bee5bd:0xf00235c3b74831c0!8m2!3d46.6290879!4d-123.0614752>



# Barley Trials

- Barley trials
  - Selected based on agronomic data, want to know differences in flavor/aroma
  - Chemical analysis done on hot water steepers and fresh-make whiskey from 2017 harvest
  - Work just starting on 2018 harvest (malt we used for today) and year 1 aged whiskies



# Barley Trials

- Analytical results
  - Differences in flavor precursors
    - Polyunsaturated fatty acids
  - Differences in terpene content
    - Plant-based aroma compounds
  - No insight on whether differences are noticeable





# Barley Trials

- Barley aromas
  - “Grainy” – n-butanal, isobutyraldehyde
  - “Bready” – 2-acetyl-1-pyrroline
  - “Nutty” – 2-methylbutyraldehyde
  - “Grassy” – cis-3-hexenal, dimethylsulfide
  - “Earthy” – 1-octen-3-ol, 2-octanone
  - “Floral” - linalool



# Barley Trials

- Barley aromas
  - Sensory data can be used alongside analytical data to determine whether differences in strains are detectable
    - Descriptive analysis using sensory panelists
  - Future sensory work will be done on fresh-make whiskeys and beers made from each strain to determine if differences appear in the final products



## Hot Steep Methodology

- Developed at Briess Malt & Ingredients Co.
- Beta tested by Briess, New Belgium, and Highland Brewing
- Validated by ASBC Sensory Technical Committee



*Casey Poirier*



*Lindsay Barr*

*Anna Sauls*



# BASE MALT FLAVOR MAP™





# Hot Steep Methodology







# Hot Steep Methodology





# Hot Steep Methodology





## Download App for Analysis/Voting



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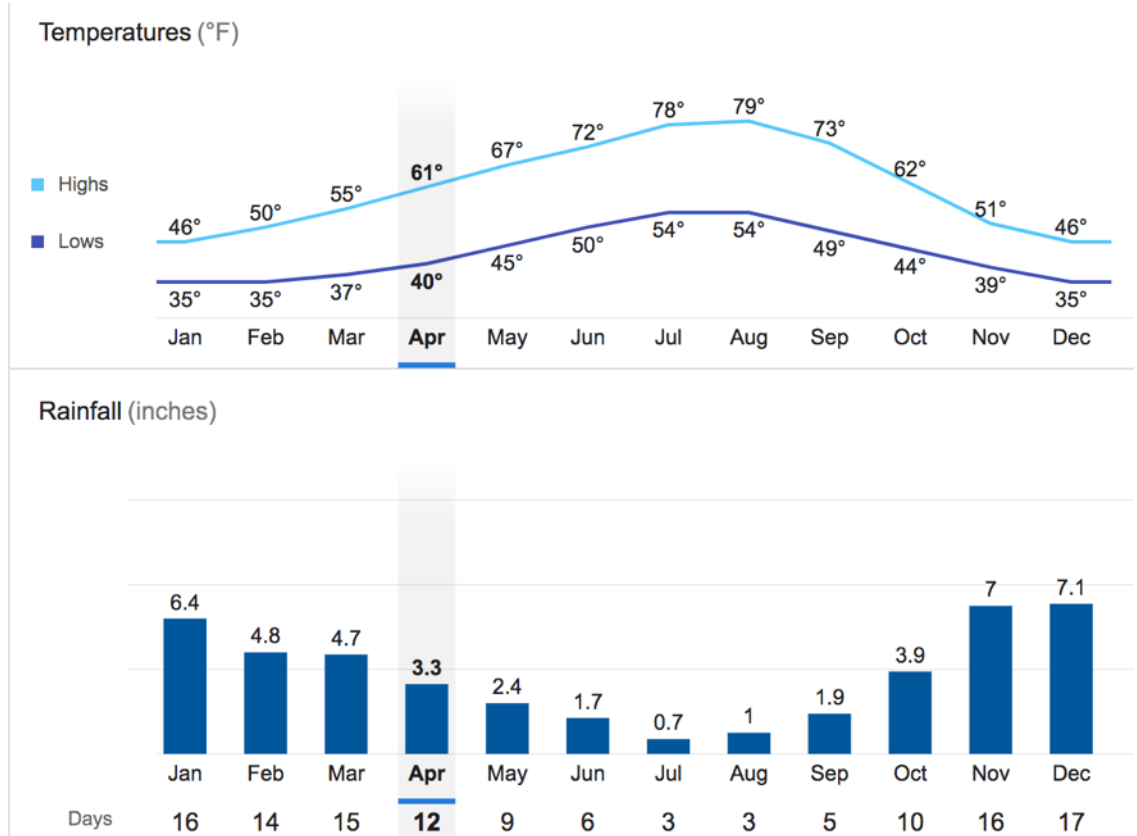
NMEYM

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## Location

- Adna, WA
- Chehalis silt loam & Newberg fine sandy loam
- 1.5 acre plots
- Low rust pressure and lodging



Source: NOAA

## Samples

- (162) CDC-Copeland
- (328) 117.17
- (680) 120.14
- (951) 120.17