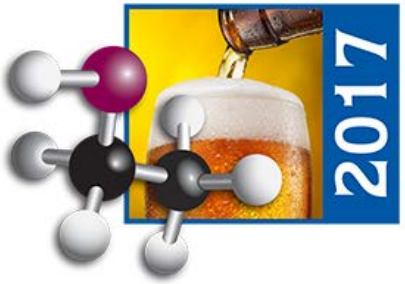


ASBC Annual Meeting

June 4–7 ■ Fort Myers, Florida

See what SCIENCE can brew for you

Sensory Evaluation of Hops

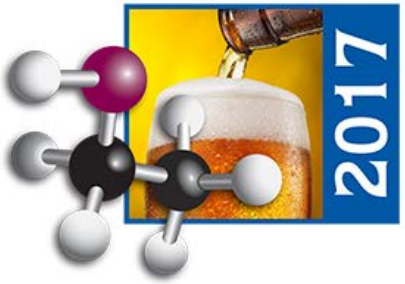
Victor Algazzali, John I. Haas

Tiffany Pitra, Hopsteiner

Daniel Vollmer, Anheuser-Busch InBev

Agenda

- Practical Hop Selection
- Hop Sensory Evaluation Methods
- Developing a Hop Sensory Panel
- Training and Validating a Hop Sensory Panel
- Resources
- Hop Evaluation Exercises



ASBC Annual Meeting

June 4–7 ■ Fort Myers, Florida

See what SCIENCE can brew for you

Practical Hop Selection

Daniel Vollmer, Ph.D.

Anheuser-Busch Inbev

Goals of Hop Selection & Evaluation

Primary:

- Procure hops that meet *quality* needs
- Procure hops that meet *pricing* needs

Secondary:

- Experimental hops
- Feedback to the breeder

Start with a plan…

Going to hop selection with a plan is key

- How much do you need?
  - Brand volume = Hop needs per variety
- How will you use it?
  - Kettle hop?
  - Dry hop?
  - Whole cone?
- Define your own expectations for quality…

Expectations for Hop Quality

What is hop quality?

- "*Beauty* is in the eye of the beholder"!
- "***Quality*** is in the eye of the beholder"!

Defining your own hop quality…

- Free of defects (no smoke, foreign material, petrol)
- In good condition (no/low disease, no shatter, clean)
- Aroma Expectations met/exceeded

Subjective vs. Objective

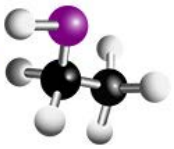
Subjective:

- **Example**: I love this farm, I love this place, they make me such a nice BBQ! Farmer X is always nice to me and therefore I love his/her hops – let's buy them!

Objective:

- **Example**: YOY we are pleased with the quality provided by Farmer X. According to our rubric, as measured by 3 assessors Farmer X has high scores for pick quality, physical quality, and aroma within each variety – let's buy them!

You can have the best of both worlds – ask hard questions and remain objective! You are the customer!



Hop Evaluation at ABI

- Brewer's Cut per 50 bales for each lot
- Hand-evaluation by a small team
- Each cut is scored for:
  - Pick quality (stems, sticks, leaves)
  - Appearance quality (shatter, disease, seeds)
  - Aroma quality (does it meet my expectations for variety X)
  - 1-5 scale for each category
- Lots are accepted or rejected based on this score
- Aroma rules the day…most of the time!

	Pick		Appearance		Aroma	
Unusual Rare	1	Unusually nice, far above average	1	Unusually nice, far above average	1	Unusually nice, far above average
Most will be here	2	Meets expectation, normal, good	2	Meets expectation, normal, good	2	Meets expectation, normal, good
	3	Below expectations, no great concerns	3	Below expectations, no great concerns	3	Below expectations, no great concerns
Small Percentage	4	Below expectations, may be a problem, hops accepted but put on hold	4	Below expectations, may be a problem, hops accepted but put on hold	4	Below expectations, may be a problem, hops accepted but put on hold
Reject	5	Far below expectations, great concerns	5	Far below expectations, great concerns	5	Far below expectations, great concerns
		How clean the hops are picked. Here, absence of unwanted leaf and steam as non-hop material is graded		*Refers to evaluation of the hops by sight. The color of hops, lack of disease and mechanical damage are evaluated*		*Grades the aroma of the hops. Is the aroma as expected, too weak, harsh, or have off-notes denoting problems*

- Standardize this procedure (SOP)
- Train a small team
- Procedure to REJECT with confidence
- Keep the data YOY

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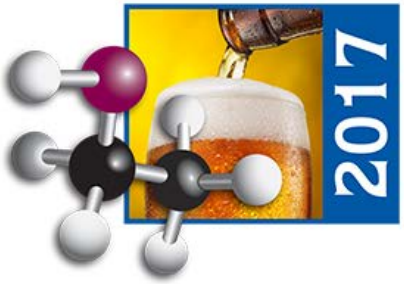
Feedback to the Supplier

- Using experimental hops
- Communicate back to the hop breeder!
  - What variety?
  - What beer?
  - How were they used?
  - Sensory results
  - Are you interested?

Experimental Hops shouldn't be only thought of as an opportunity to make "one-off" creative projects, but rather as a conduit for alternatives and replacements



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June 4–7 ■ Fort Myers, Florida

See what SCIENCE can brew for you

Sensory Evaluation of Hops: Part I

Tiffany Pitra

Hopsteiner

Supplier Applications of Hop Sensory

- Training
- Quality Control
  - Determining variations (lot-to-lot, crop year, etc.)
  - Sample testing for customers
- Research and Development
  - Brewing trials
  - Variety substitutions
  - New product testing

Supplier Applications of Hop Sensory

Variety Development: Advancing and Describing New Varieties

Year 0 - 1

- Selection of parents
- Seedling Screening
- Agronomic traits

Year 2 – 3
Single-Hill Evaluation

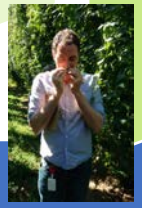
- Agronomic traits
- Chemical traits
- Maturity
- Aroma

Year 4 – 6
Multi-Hill Evaluation

- Agronomic traits
- Chemical traits
- Environmental variables
- 1st brewing trials

Year 7 – 10
Semi-Commercial

- Confirmation on agronomic and chemical traits
- Extensive brewing tests



seedlings

5 – 10 varieties

Hop Sensory Evaluation Methods

- Hand rub
  - + Industry standard for Hop Selections
  - + Limited sample prep
  - - Aroma carryover
  - - Fatigue
  - - Not standardized
- Hop grind
  - + Reasonable sample prep
  - + Standardized
  - - Fatigue
- Hop tea
  - + Limited fatigue
  - + Standardized
  - - Greater sample prep

Hop Sensory Evaluation Methods

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WORLD BREWING CONGRESS 2016

Hop Tea Sensory Method

Amanda Benson, Victor Algazzali, Lindsay Barr, Tiffany Pitra

Deschutes Brewery, John I. Haas, New Belgium Brewing Company, Hopsteiner

World Brewing Congress
August 13-17, 2016
Sheraton Downtown Denver
Denver, CO 80202, U.S.A.

Introduction

The purpose of this method is to create a cold water extract of hops for sensory analysis. The water extract or "hop tea" can be used to assess the potential aroma quality of hops.

Materials

Reagents

- Filtered water at 25ºC
- Hop pellets or whole cones

Apparatus

- *Glass French Press*, 1.5L
- *Thermometer*, standard, 0-200ºC
- *Glass Nalgene*, 1.0L, screw-top liquid container PP/PE/PET
- *Magnetic Stir Bar*, 2 x 5/16
- *Stir plate*
- *Timer*
- *Blade Grinder*, Magic Bullet ™ (or equivalent), 2 cup capacity
- *Mass Balance*, capable of weighing 50g ± 0.01g

Method

1. Weigh out 20g hop pellets or 24g cones (add a 20% multiplier when using cones to achieve similar aroma intensity).
2. Using a blade coffee grinder, grind the hop material for about 10 seconds for pellets and 20 seconds for cones or until a fine powder is achieved.

Method

3. Fill a graduated cylinder with 25ºC water up to the 1L mark
4. Place a 2 x 5/16 inch magnetic stir bar in the bottom of the glass French Press
5. Add the ground hop material to the bottom of the French Press beaker
6. Gently add 1L 25ºC water to the French press beaker being sure to completely submerge the hop material with water. Attach the lid plunger and depress the plunger so it gently rests above the material
7. Place the full French Press on the stir plate and set the mixing speed to about 180 RPM (or about 4 if using a stir plate that does not have RPM settings) and allow the hop water solution to stir for 20 minutes.
   1. Note: the liquid should be in constant motion but should not be spinning fast enough to have a "tornado" effect.
8. After 20 minutes, turn off the stir plate and remove the beaker.
9. Press down on the plunger filter to strain the hop tea and remove the hop particulate. Decant the hop tea into a 1.0L glass Nalgene screw-top liquid container, and use for sensory analysis immediately or refrigerate for storage.
   1. Note: Do not store for longer than 5 hours. If refrigerating, bring the teas back up to room temperature (~21ºC) before evaluation.

	Pellet Repeatability			Cone Repeatability		
Collaborator	Correct Identifications	Significant at α=0.10	Critical Response	Correct Identifications	Significant at α=0.10	Critical Response
1	8 out of 18	No	10	10 out of 18	Yes	10
2	9 out of 20	No	10	3 out of 15	No	8
3	3 out of 11	No	7	5 out of 10	No	6
4	5 out of 9	No	6	1 out of 9	No	6
5	5 out of 11	No	7	4 out of 10	No	6
6	3 out of 14	No	8	4 out of 14	No	8
7	7 out of 15*	No		0 out of 10	No	6
8	11 out of 19	Yes	10	8 out of 20	No	10
9	4 out of 11	No	7	1 out of 11	No	7
Total	48 out of 113			36 out of 117		
	55 out of 128*			*results compromised, not included		

	Small Difference Pellet			Small Difference Cone		
Collaborator	Correct Identifications	Significant at α=0.10	Critical Response	Correct Identifications	Significant at α=0.10	Critical Response
1	14 out of 18	Yes	10	10 out of 16	Yes	8
2	12 out of 17	Yes	9	14 out of 16	Yes	8
3	5 out of 11	No	7	7 out of 11	Yes	6
4	7 out of 9	Yes	6	7 out of 9	Yes	5
5	6 out of 11	No	7	7 out of 10	Yes	5
6	11 out of 14	Yes	8	13 out of 19	Yes	9
7	9 out of 12	Yes	7	8 out of 10	Yes	5
8						
9	7 out of 11	Yes	7			
Total	71 out of 103			66 out of 91		

	Large Difference Pellet			Large Difference Cone		
Collaborator	Correct Identifications	Significant at α=0.10	Critical Response	Correct Identifications	Significant at α=0.10	Critical Response
1	13 out of 16	Yes	8	15 out of 16	Yes	8
2	12 out of 14	Yes	7	12 out of 13	Yes	7
3	8 out of 11	Yes	6	7 out of 11	Yes	6
4	8 out of 9	Yes	5	6 out of 9	Yes	5
5	7 out of 11	Yes	6	9 out of 10	Yes	5
6	18 out of 19	Yes	9	17 out of 19	Yes	9
7	13 out of 21	Yes	10	10 out of 11	Yes	6
8	9 out of 11	Yes	6	12 out of 19	Yes	9
Total	88 out of 112			88 out of 108		

Results

The hops used in this study were 2015 Idaho Cascade, 2014 Oregon Cascade, and 2015 Oregon Centennial, for both the pellet and cone samples. The hops used in the repeatability tests were 2015 Idaho Cascade. To asses the level of sensitivity two different tests were run. For large differences samples from different varieties were used and for moderate differences the same variety, but from different years. The hops used in the "moderate" difference tests were 2015 Idaho Cascade and 2014 Oregon Cascade. The hops used in the "large" difference test were 2014 Oregon Cascade and 2015 Oregon Centennial. Each test was completed with pellet and cones, respectively.

To assess repeatability, the same hop sample was prepared by two different technicians in the same laboratory according to the Hop Tea method. The hop tea samples were served to a sensory panel and a triangle test was administered. The number of panelists who correctly identified the odd sample in the triangle was recorded. If samples prepared by two different technicians were not significantly different (α=0.10), the Hop Tea method was considered to be repeatable. Conversely, the method could be considered sensitive if there was a significant difference (α=0.10) in the tests between the 2015 Idaho Cascade/2014 Oregon Cascade and 2014 Oregon Cascade/2015 Oregon Centennial. The hop tea samples were served to a sensory panel and a triangle test was administered. The results from the 9 different sensory panels that participated in this study are presented in the tables.

Conclusion

At a confidence level of 90% this method was deemed repeatable, with 7 out of the 8 collaborators (88%) not finding a significant difference, for both pellet and cone repeatability trials. This success rate was deemed suitable and within the range of acceptable variation by the committee. All of the sensitivity tests were significant, meaning differences could be picked out with this method. This is a simple and cost effective method that could be used in quality control of hop inventory, sensory assessment of new varieties, training a sensory panel on the characteristics of new hop varieties or as an alternative to the hop rub.

HAAS Hopsteiner

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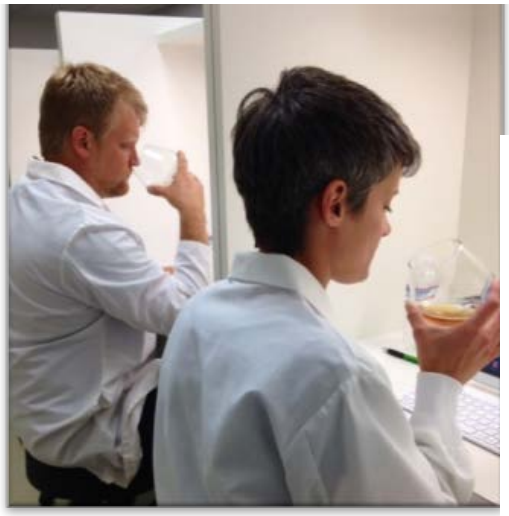
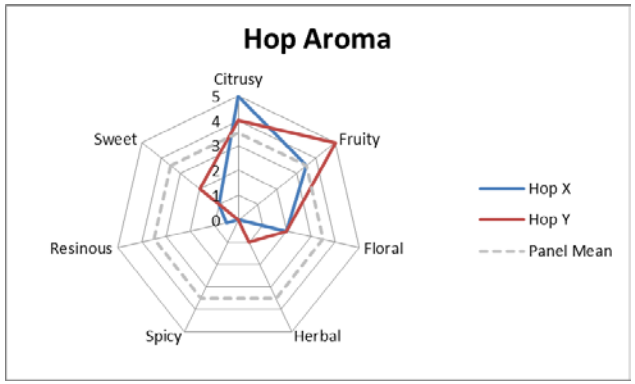
Hop Sensory Evaluation Methods

- Beer trials
  - Standardized recipe(s) for evaluation of hop aroma, flavor and bitterness in beer
    - Evaluate new hop products or varieties
    - Evaluate variety substitutions



Hop X

Hop Y



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Developing a Hop Sensory Panel

- Panelist recruitment and screening
  - Interdepartmental
  - Availability, interest and motivation
  - Sensory impairment, sensory acuity and descriptive ability
- Lexicon development
  - Is your language universally understood?
  - Reasonable (trainable) number of terms
  - Reference standards








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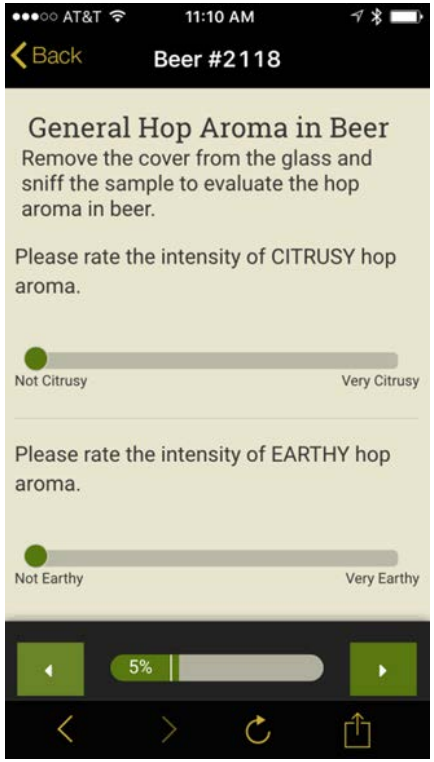
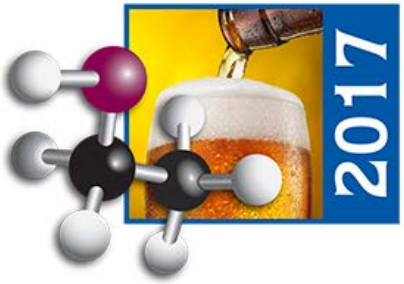
Developing a Hop Sensory Panel

- Ballot design
  - What information do you want to know?
  - How will you collect this data?
    - Question types
    - Scaling
  - Is your panel trained to answer those questions?
- Evaluation protocol
  - Standardize panel protocol for sample evaluation
  - Incorporate recovery time to limit fatigue



Train, Train…and Train again!



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June 4–7 ■ Fort Myers, Florida

See what SCIENCE can brew for you

Sensory Evaluation of Hops: Part II

Victor Algazzali

John I Haas, Inc.

Training a Descriptive Analysis Panel

Training

Identify Flavors

Scale Intensity

Descriptive Analysis

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The Importance of Standards

- Reference flavors for the language that are tools for training

Written definition		Sensory definition
Floral – *geranium, jasmine, rose, lavender, lily, dandelion*	**vs.**	

- Representations of a flavor category
  - Can be a single dimension of the category and not comprehensive
- Help ensure that panelists are speaking the same language
- Establishes a mutually agreed upon reference

What I think of as Floral, is what you think of as Floral

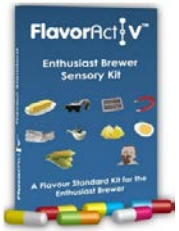
Flavor Standard Options

Fresh Foods

Essential Oils

Sensory Kits

aroxa



Flavor Compounds

VIGON

TREATT

SIGMA-ALDRICH

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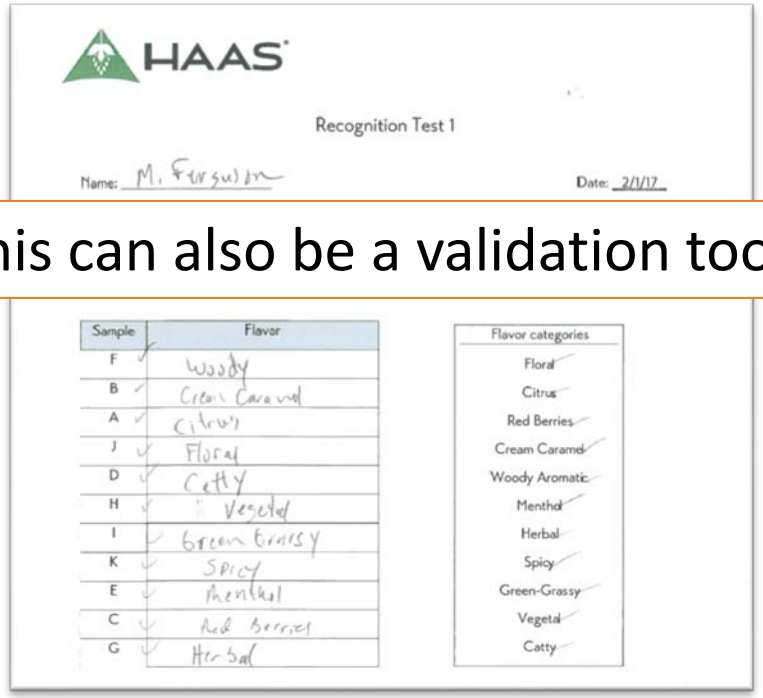
Training to Identify Flavors

Recognition Testing

- Blind testing to determine if panelists can identify the standards, i.e. the flavors of the language
- Practice describing and categorizing flavors in a blind setting


HAAS

Recognition Test 1

Name: M. Ferguson Date: 2/1/17

Sample	Flavor
F	Woody
B	Cream Caramel
A	Citrus
J	Floral
D	Catty
H	Vegetal
I	Green Grassy
K	Spicy
E	Menthol
C	Red Berries
G	Herbal

Flavor categories
Floral
Citrus
Red Berries
Cream Caramel
Woody Aromatic
Menthol
Herbal
Spicy
Green-Grassy
Vegetal
Catty

This can also be a validation tool

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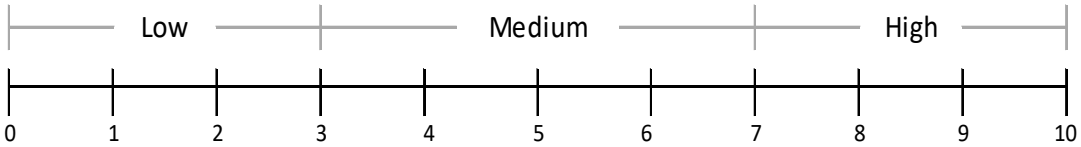
Teaching to the Test

Training

Identify Flavors

Scale Intensity

Descriptive Analysis



Training to Scale Intensity

Intensity Testing

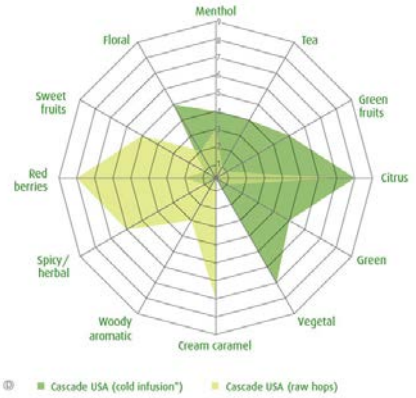
- Blind testing to determine if panelists can scale the intensity of flavors.
- Use standards at varying concentrations to create different intensity levels of a flavor, e.g. “low”, “med”, & “high” or 1, 5, & 10.

Anchors

- Similar to standards. Samples in your medium (hops, beer, etc.) that represent flavors intensities of your language.
- Example: the panel agrees that Cascade hops typically have a Citrus score between 6 – 10.

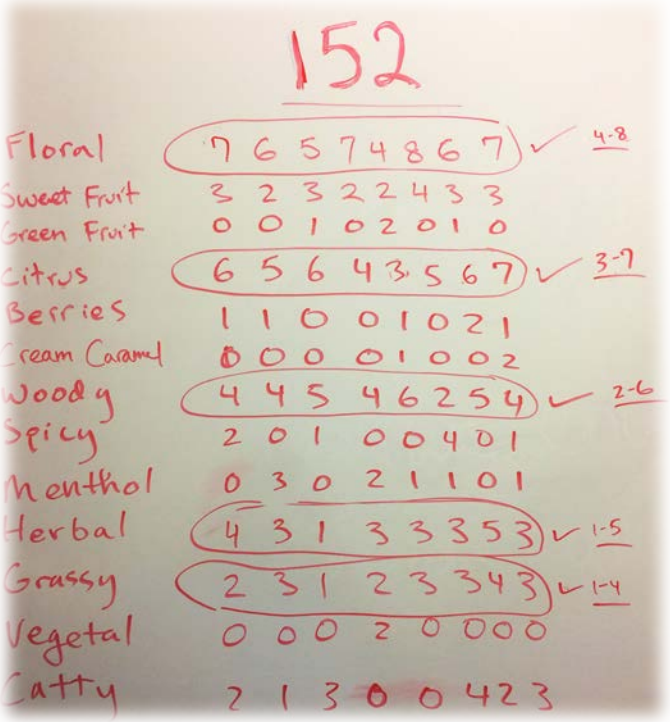
Cascade

Flavor	Intensity
Citrus	6 - 10
Floral	4 - 6
Pine	3 - 5



Round Table Scoring & Discussion

- Share flavor scores and comments
- Demonstrate data analysis
  - Give panelists insight into sensory data analysis
  - Emphasize the importance of using the whole scale
- Revisit sample after scoring
  - Does the panel's score accurately represent the sample?



Analyzing and Using Sensory Data

- Average data
- Heat Maps
- Histograms
- ANOVA
- Cluster Analysis
- PCA

	Cascade	Citra	Willamette	Loral
Floral	8	6	4	9
Fruity	5	10	0	0
Citrus	6	10	0	7
Sweet Fruit	5	8	0	0
Green Fruit	2	4	0	4
Red Berries	0	0	0	1
Cream Caramel	0	0	2	0
Woody	4	0	6	2
Menthol	0	0	4	0
Herbal	5	0	8	6
Spicy	0	0	5	0
Green-Grassy	0	0	8	5
Vegetal	0	6	0	0
Catty	0	10	0	0

Resources

- ASBC MOA: Sensory
- ASBC Sensory Subcommittee Webinars
- ASBC Flavor Standards Spiking Calculator
- Contact fellow ASBC members
- Contact your hop supplier – give us a call!

Hop Sensory Exercises

- Hop Selection
  - 5 Samples
  - -Describe
  - -Rank in order of preference
  - -Identify the odd sample
- Name that Variety
  - 5 Samples
  - Correctly identify & describe the following:
  - Cascade, Centennial, Mosaic, Willamette, Zeus

How to fill out the Master Ballot

1. Elect one team Captain per table
2. The team Captain collects ballots from those seated at their table
3. The team Captain records a table rank sum for each sample by adding each rank number across each sample ID row:

John's ballot

Sample ID	Comments	Rank 1= most preferred 5= least preferred
942		2
170		3
328		1
455		5
806		4

Jane's ballot

Sample ID	Comments	Rank 1= most preferred 5= least preferred
942		1
170		2
328		3
455		4
806		5

942 = 2 + 1 = 3

170 = 3 + 2 = 5

328 = 1 + 3 = 4

455 = 5 + 4 = 9

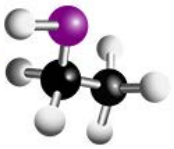
806 = 4 + 5 = 9

How to fill out the Master Ballot

4. Record these totals in the “Rank Sum” column on the Master Ballot
5. Submit the Master Ballot to the session moderator as soon as you have finished.
6. Return individual ballots to those seated at your table

Master Ballot

Sample ID	Rank Sum
942	3
170	5
328	4
455	9
806	9



Answer Key: Name that Variety

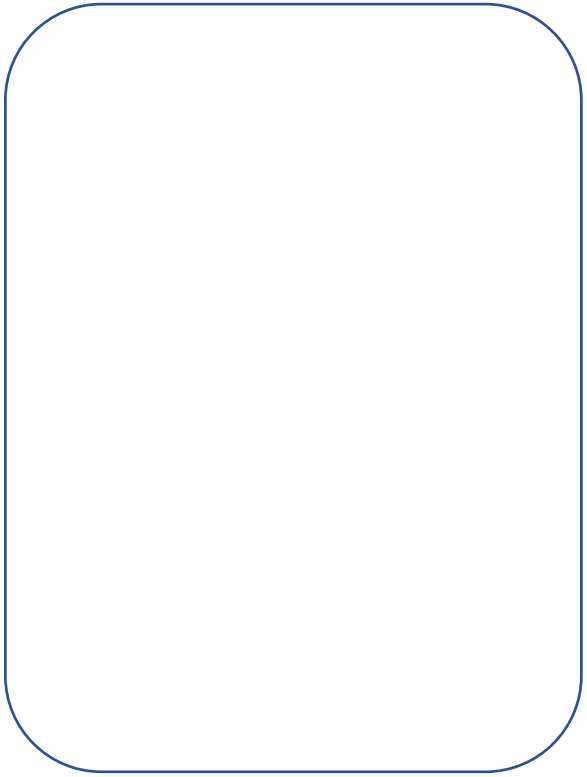
783

582

249

102

316



Results: Cascade Hop Selection