



# Consumer Sensory Engagement

2020 Craft Malt Conference



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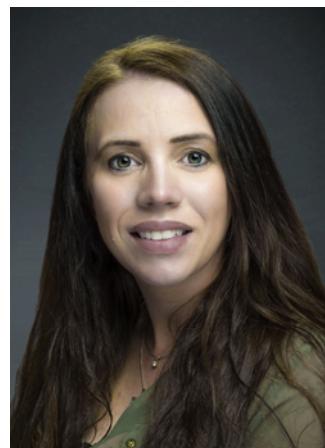
*Aaron Macleod*



*Brian Estes*



*Joel Williamson*



*Hannah Turner*





*Stephen  
Bramwell*



*Laura  
Lewis*



*Kevin  
Murphy*



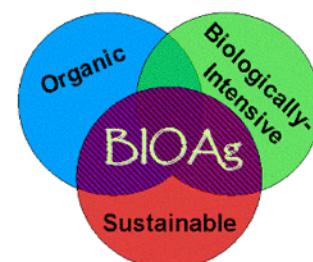
*Carolyn  
Ross*



*Cedric  
Habiyaremye*

*Halle  
Choi*

*Julianne  
Kellogg*





*“To appreciate something you must understand it, and to understand something you must experience it.”*

# LYON

- Two-rowed spring feed/malt barley (2013)
- Baronesse/Spaulding



## LYON

SPRING BARLEY

Lyon is a two-row dual-purpose malt and feed barley developed by the Agricultural Research Center of Washington State University. Lyon is named in honor of Steven R. Lyon, a farmer and long-time wheat researcher at Washington State University.

Lyon is a high yielding, broadly adapted variety particularly well suited to intermediate and high rainfall zones of the Palouse where Bob, Baronesse, Lenatah, and Champion are currently being grown. Lyon has excellent stem rust resistance, high protein, and plump kernels across a wide range of environments.

### AGRONOMICS

Yield Potential.....	Excellent
Protein .....	Very Good
Test Weight.....	Average
Maturity.....	Medium
Height.....	Medium
Plump Kernels.....	Excellent

### DISEASE RESISTANCE

Stem Rust.....	Excellent
Leaf Rust.....	Excellent
Stripe Rust.....	Moderately Susceptible

## WSU INSIDER

FOOD & AGRICULTURE

# WSU-bred barleys delivering unique Northwest beer flavors

May 15, 2018

"MAINSTEM HAS PROUDLY WORKED WITH WSU'S LYON 2-ROW BARLEY SINCE 2017. WHILE NOT TYPICALLY USED FOR MALTING, WE'VE ENJOYED ITS LEADING DROUGHT TOLERANCE, DISEASE RESISTANCE, SMALL BATCH MALTING PERFORMANCE, AND SOME NOTEWORTHY CRAFT BREWING QUALITIES. LOOK TO LYON AS THE START OF A GREAT STORY. WE ASK THE BEVERAGE INDUSTRY JOIN US IN SUPPORT OF WSU'S LAND GRANT RESEARCHERS AND THEIR NEXT CHAPTER OF CRAFT MALTING BARLEYS, BRED TO THRIVE IN THE UNIQUE DRYLAND CLIMATES OF THE PACIFIC NORTHWEST."

MAINSTEM MALT, WALLA WALLA, WA

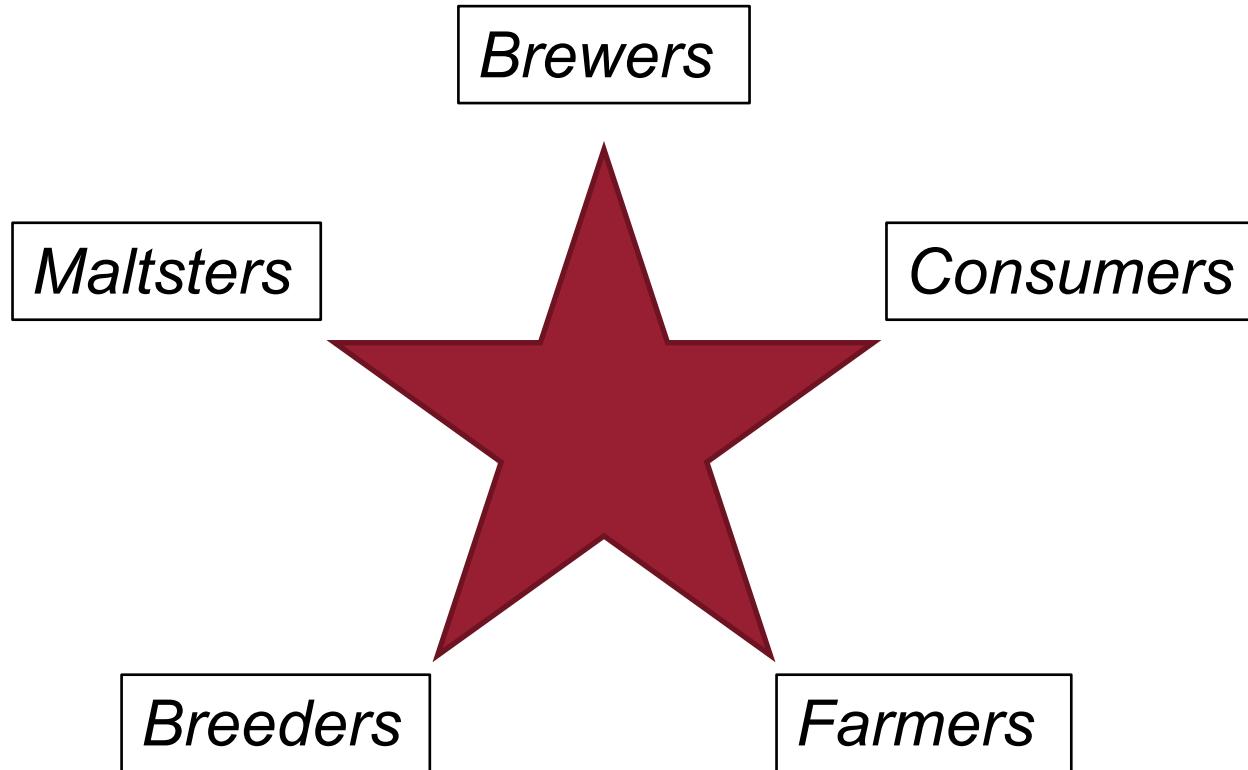


"ACROSS MALT STYLES, LYON PRESENTS FOCUSED AND BRIGHT FLAVOR PROFILES, WITH HONEY AND FRESH GRASS CENTRAL TO LIGHTER MALTS, AND LIGHT EARTH AND CRACKER COMING THROUGH IN HIGHER KILNED RECIPES. THE LYON VARIETAL IS CONSISTENTLY HIGHER IN BETA-GLUCAN THAN STANDARD MALTING BARLEYS, BUT WITH ATTENTION THIS TRAIT HAS PROVEN TROUBLE FREE."

LINC MALT, SPOKANE, WA



# BREEDING A MALT QUALITY BARLEY



**TITLE: FROM GROUND TO GLASS: EVALUATION OF UNIQUE BARLEY VARIETIES FOR WESTERN WASHINGTON CRAFT MALTING, BREWING AND DISTILLING**



**PRINCIPAL INVESTIGATOR(S) AND COOPERATOR(S): STEPHEN BRAMWELL (PI), DR. KEVIN MURPHY (Co-PI), DR. THOMAS COLLINS (Co-PI)**

## 2017 TRIAL: GRAIN AND MALT QUALITY

- No significant difference in yield; comparable to Copeland
- Replicated (3) data from Cereal Crops Research Unit
- **Grain and micromalt quality (Hartwick, unreplicated)**
- Pilot Malting (Oregon State University) -> malt quality
- Hot steep & beer consumer panel



*Stephen  
Bramwell*



## 2017 Trial: Grain Quality

	Moisture (%)	Protein (% DB)	Test Weight (lbs/bu)	Plump (6/64" %)	GE 4ml (%)	GE 8ml (%)
Copeland	13.4	10.3	48.9	99.6	100	91
117.17	14.9	9.9	50.1	98.4	100	82
107.43	15.0	10.0	52.9	99.1	97	80
120.14	15.4	10.1	50.6	98.7	96	90
120.17	16.9	10.3	49.7	99.1	97	87



Center for Craft Food & Beverage

# 2017 Trial: Micromalt Quality

	Friability (%)	Fine Extract (%)	Color (°SRM)	β-Glucan (ppm)	S/T (%)	FAN (mg/L)	DP (°L.)	Alpha Amylase (D.U.)
Copeland	94.9	81.9	2.44	75	49.9	232	131	58.5
117.17	84.5	80.6	1.60	340	40.7	156	94	31.0
107.43	73.2	82.4	1.57	471	40.8	157	86	33.9
120.14	82.0	81.7	2.49	195	47.5	217	98	46.1
120.17	81.8	81.1	2.39	228	45.0	202	95	39.0



Center for Craft Food & Beverage

	<b>Entry</b>	<b>Steep</b>	<b>Germ</b>	<b>Kiln</b>
<b>Hartwick (standard)</b>	All	8 hrs wet (16 hrs air) 6 hrs Wet (14 hrs air) 2 hrs wet @ 14°	96 Hours @ 15°C	6 hrs @ 55°C, 6 hrs @ 65°C, 6 hrs @ 72°C, 4 hrs @ 85°C
<b>OSU (modified minimally)</b>	Copeland	8 hrs Wet (16 hrs Air) 8 hrs Wet (12 hrs Air) 2 hrs Wet @ 14° C	96 Hours @ 15°C	5 hrs @ 50°C, 5 hrs @ 55°C, $\Delta T = 9$ @ 60°C, 6 hrs @ 72°C, 4 hrs @ 85°C
<b>OSU (modified)</b>	120.14 120.17	8 hrs Wet (16 hrs Air) 8 hrs Wet (12 hrs Air) 2 hrs Wet @ 14° C	120 Hours @ 15°C	5 hrs @ 50°C, 5 hrs @ 55°C, $\Delta T = 9$ @ 60°C, 6 hrs @ 72°C, 4 hrs @ 85°C
<b>OSU (modified)</b>	117.17 107.43	<b>5 hrs Wet (19 hrs Air)</b> <b>5 hrs Wet (15 hrs Air)</b> <b>2 hrs Wet @ 18°</b>	120 Hours @ 15°C	5 hrs @ 50°C, 5 hrs @ 55°C, $\Delta T$ = 9 @ 60°C, 6 hrs @ 72°C, 4 hrs @ 85°C

# 2017: Pilot Malt Quality

Entry	Friability (%)	Fine Extract (%)	Color (°SRM)	β-Glucan (ppm)	S/T (%)	FAN (mg/L)	DP (°L.)	Alpha Amylase (D.U.)
Copeland	87.5	81.3	2.20	85	44.4	193	122	64.8
117.17	89.1	79.5	1.84	99	40.9	151	106	47.8
107.43	87.9	81.5	1.87	95	37.7	155	101	47.6
120.14	86.1	81.5	2.79	127	44.7	208	102	60.9
120.17	84.4	80.9	2.49	130	42.4	190	100	56.7



Center for Craft Food & Beverage

# Brewing

- 5.5lb mash weight
- 1 oz Tahoma Hop (6.5% alpha)  
@ 60min
- 3gal fermentation volume
- Wyeast 1056 American Ale Yeast
- Bottled (12fl oz) under CO<sub>2</sub>



Entry	OG (sg)	FG (sg)	ABV (%)
Copeland	1.048	1.006	5.46
117.17	1.053	1.006	6.11
107.43	1.050	1.006	5.72
120.14	1.051	1.006	5.85
120.17	1.059	1.007	6.76

## Consumer Panels

- IRB #17398-002
- Day 1: Hot Steep (30mL)
- Day 2: Beer (30mL)
- 95 participants (same each day)
- Screener and survey
- Willingness to purchase
- Hedonic Scales (1-9)
  - Overall Liking
  - Appearance
  - Sweetness
  - Bitterness
  - Taste/Flavor
- Check all that apply





4H









Thank you for attending the sensory panel.  
PLEASE PRESS THE BLUE SIGNAL LIGHT TO LET THE  
EXPERIMENTER KNOW YOU ARE HERE.

Can you keep a secret?  
We value everyone's individual opinion - so please  
keep your answers or comment on your evaluation of the  
samples with your fellow panelists (either in the booth or in  
the hallway). Thank you.



**Grassy:** includes hay, dry grass, limey, dry seeds, herbage, green plants, green tea, and  
lemon grass.

**Nutty:** includes nuts, rice, butter, and toasted rice

**Bready:** includes dough (yeast), bread (yeast, bread crust, bread rolls, bread, yeast,  
potato, flour), sweet bread (yeast, granola, croissants), emeril's "Wheat Thins™",  
pancake, and flour

**Breakfast Cereal:** includes cereal (Crispy Nutri-B, Cheerios 40, Corn Flakes 8, Rice Flakes 8),  
flavored (brown, chocolate, and cereal)

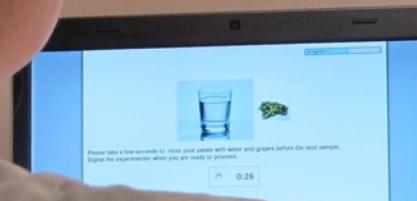
**Fruity:** includes nutmeg, apple, watermelon, and lemon

**Floral:** includes clover, dandelion, willowherb, and honeysuckle

**Honey:** the strong flavor of honey

**Earthy:** includes barnyard, dirt, moss, mineral, soil, peat, water

**Mader:** includes smoke, paper, cardboard, and mold







# HEDONIC SCALES: HOT STEEP

Attributes	p-value
Aroma	0.76
<b>Appearance</b>	<b>&lt;0.001</b>
Taste/flavor	1.0
Sweetness	0.56
Bitterness	0.12
Overall	0.87



	COPELAND	107.43	117.17	120.17	120.14
Appearance	6.24b	6.15b	6.13b	<b>6.56a</b>	<b>6.67a</b>

## HEDONIC SCALES: BEER

Attribute	p-value
Aroma	<0.01
Appearance	<0.01
Taste/flavor	<0.01
Sweetness	0.03
Bitterness	0.06
Liking overall	<0.01
Willingness to Pay	0.65

## HEDONIC SCORES: BEER

<b>Attributes</b>	<b>Copeland</b>	<b>120.17</b>	<b>120.14</b>	<b>107.43</b>	<b>117.17</b>
Aroma	5.89 c	6.33 bc	<b>6.93 a</b>	6.61 ab	6.96 a
Appearance	6.67 b	7.04 a	<b>7.08 a</b>	6.89 ab	6.91 ab
Taste/Flavor	5.53 b	6.24 a	<b>6.31 a</b>	6.02 ab	6.01 ab
Sweetness	5.53 b	5.82 ab	<b>6.06 a</b>	5.85 ab	5.69 ab
Bitterness	5.15 a	5.37 a	<b>5.59 a</b>	5.40 a	5.20 a
Overall Liking	<b>5.52 b</b>	6.05 ab	<b>6.18 a</b>	5.89 ab	5.68 ab



# CHECK ALL THAT APPLY (CATA)

## HOT STEEP

Attributes	p-value
Bready	0.809
Breakfast Cereal	0.259
Earthy	0.349
Floral	0.223
<b>Fruity</b>	<b>0.012</b>
Grainy	0.377
Grassy	0.498
Honey	0.462
Nutty	0.210
Stale	0.279
<b>Other</b>	<b>0.010</b>

*Cochran's Q Test*

## BEER

Attributes	p-value
Butter	0.146
Cereal	0.410
<b>Chemical</b>	<b>0.008</b>
<b>Citrus</b>	<b>0.021</b>
<b>Earthy</b>	<b>0.002</b>
Floral	0.759
<b>Fruity</b>	<b>0.017</b>
Grassy	0.055
Nutty	0.650
<b>Stale</b>	<b>0.028</b>
<b>Sweet</b>	
<b>Aromatic</b>	<b>0.000</b>
Yeasty	0.474
Other	0.078

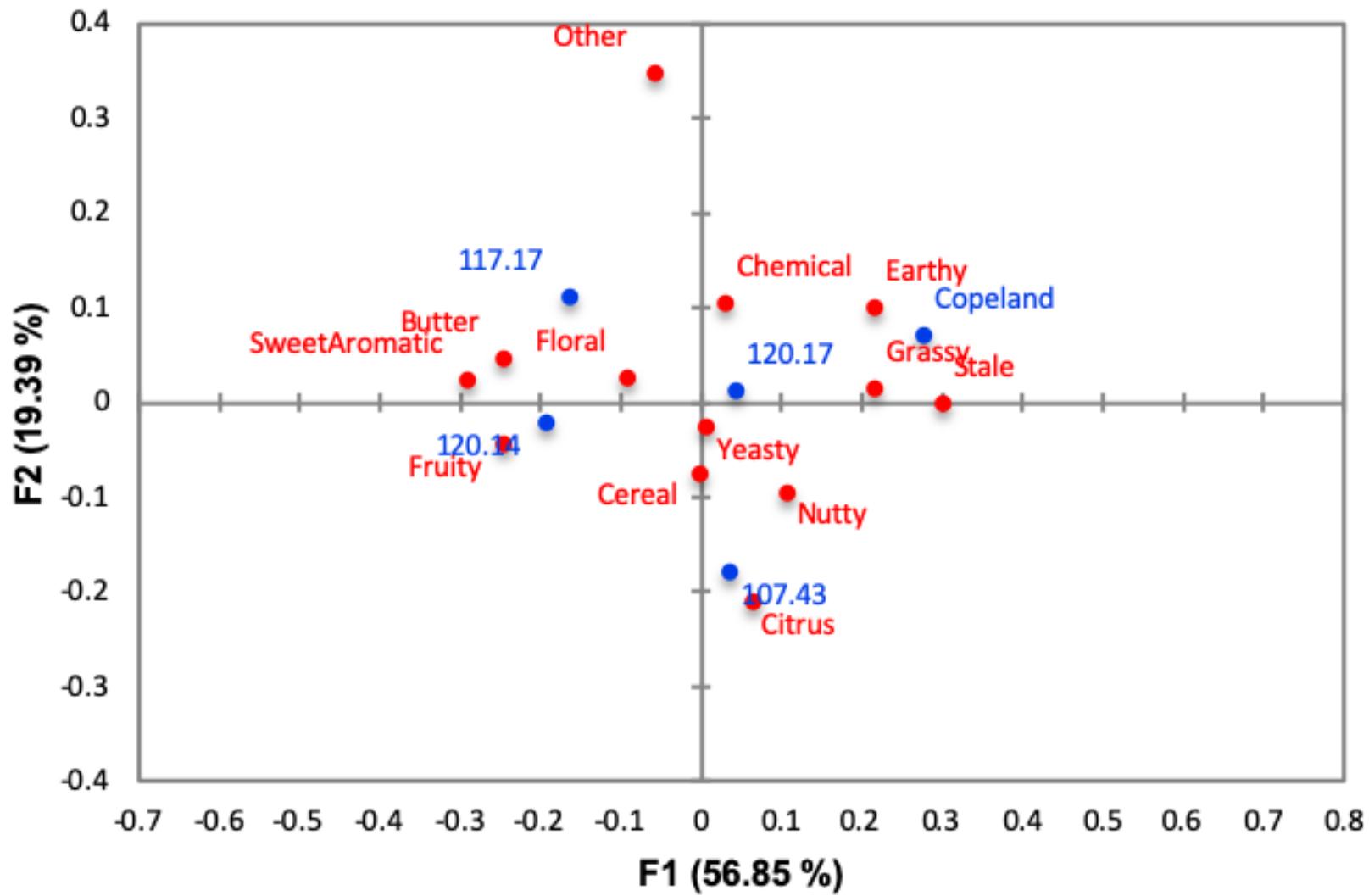
## FRUITY COMPARISON

Attributes	Copeland	120.17	120.14	107.43	117.17
Hot Steep	0.200 (b)	0.158 (ab)	0.053 (a)	0.126 (ab)	0.137 (ab)
Beer	0.149 (a)	0.170 (ab)	0.309 (b)	0.234 (ab)	0.277 (ab)

\*Copeland and 120.14 switch rank  
from Hot Steep to Beer\*

# BEER: CORRESPONDENCE ANALYSIS (ALL)

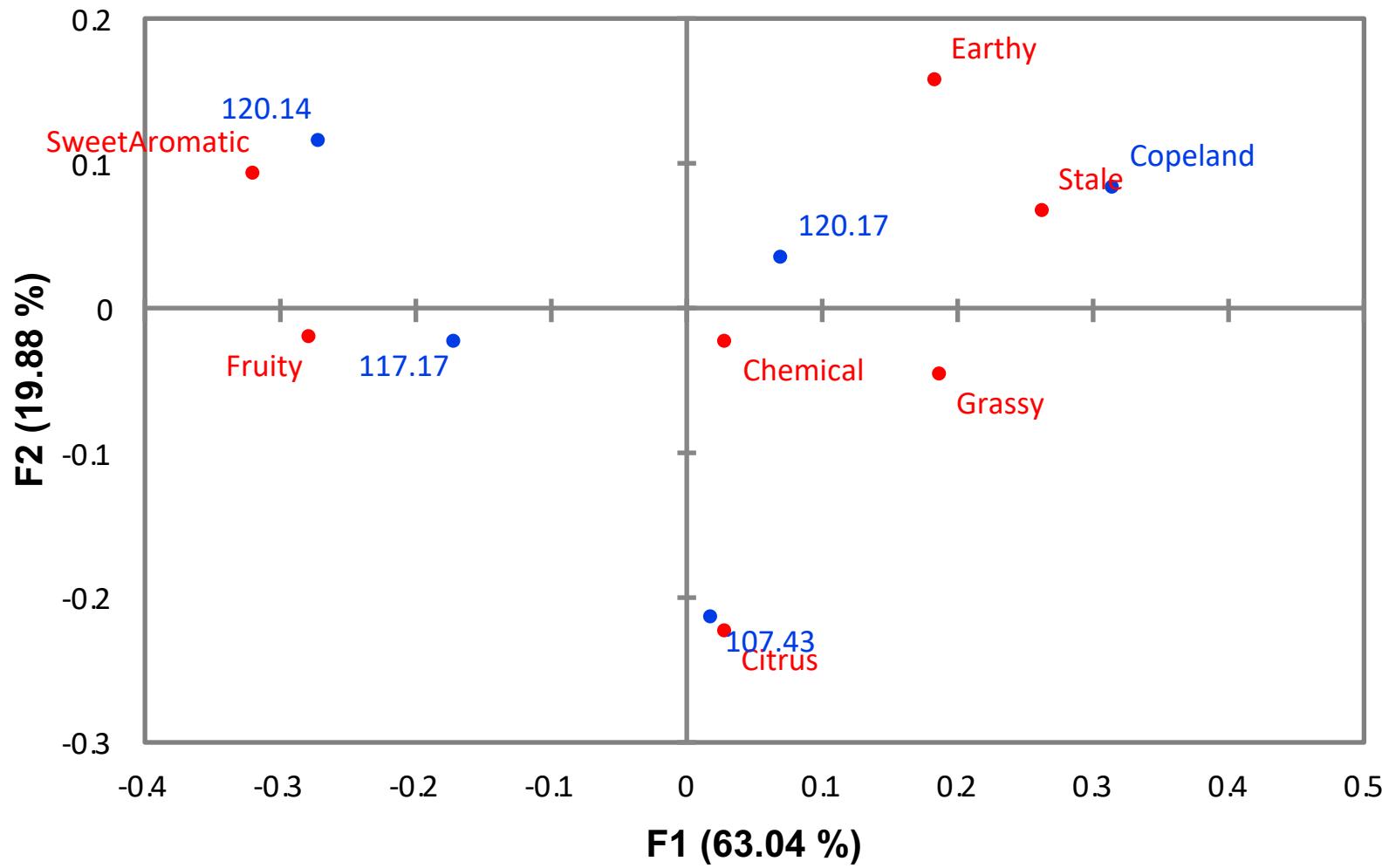
(axes F1 and F2: 76.24 %)



● Attributes   ● Products

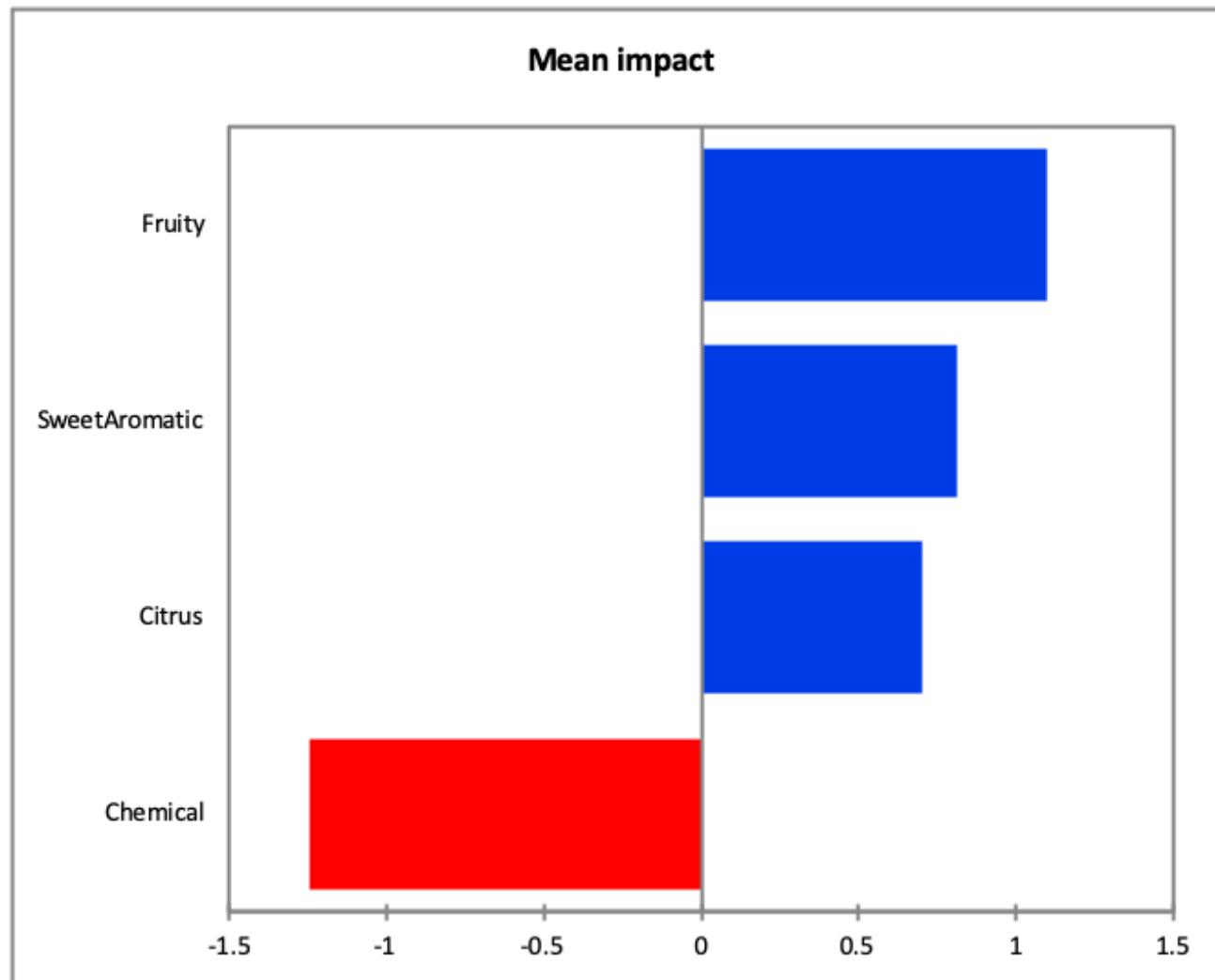
# BEER: CORRESPONDENCE ANALYSIS

(axes F1 and F2: 82.91 %)



● Attributes   ● Products

# Attribute Impact on Overall Liking of Beer



## WILLINGNESS TO PAY FOR A SIX PACK

Price	Copeland	120.17	120.14	<u>107.43</u>	117.17
\$7.99	34%	34%	25%	40%	32%
\$9.99	19%	18%	27%	20%	24%
\$11.99	6%	8%	11%	5%	6%
\$13.99	1%	3%	3%	3%	0%
I would not buy this beer	40%	37%	34%	32%	38%



## Impact and Next Steps

- Consumer Behavior
  - Comment Coding
  - Cluster Analysis
  - Logit Models
- 2018 Trial: Sensory at Scale
- MBC Seed Lab SMaSH
- Consumer education and outreach
- Palmer (107.43) variety release



*Evan  
Mulvaney*



*Brian  
Thompson*

 **Port of Olympia**



  
**Thurston  
Conservation  
District**  
  
EST 1947

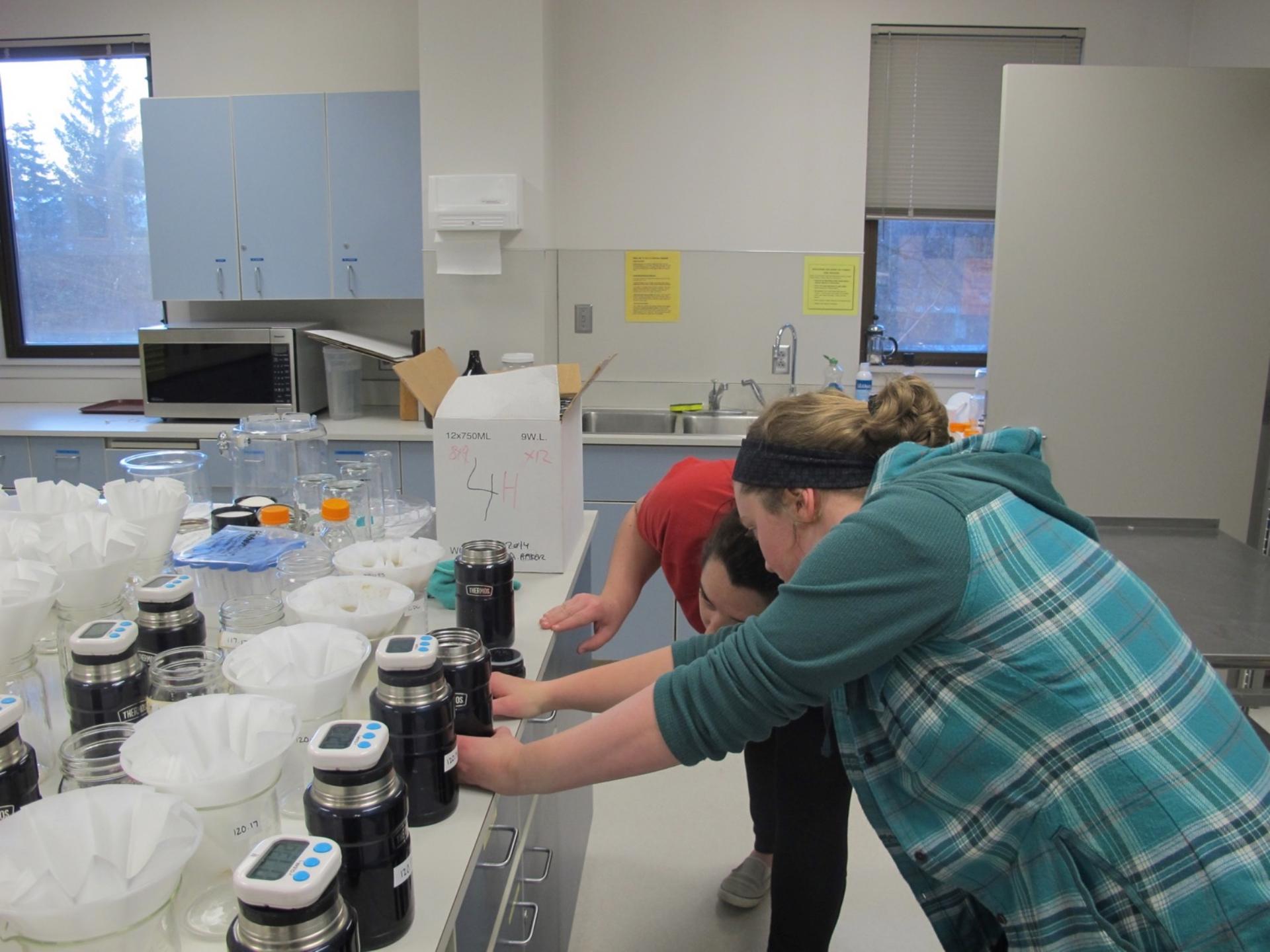


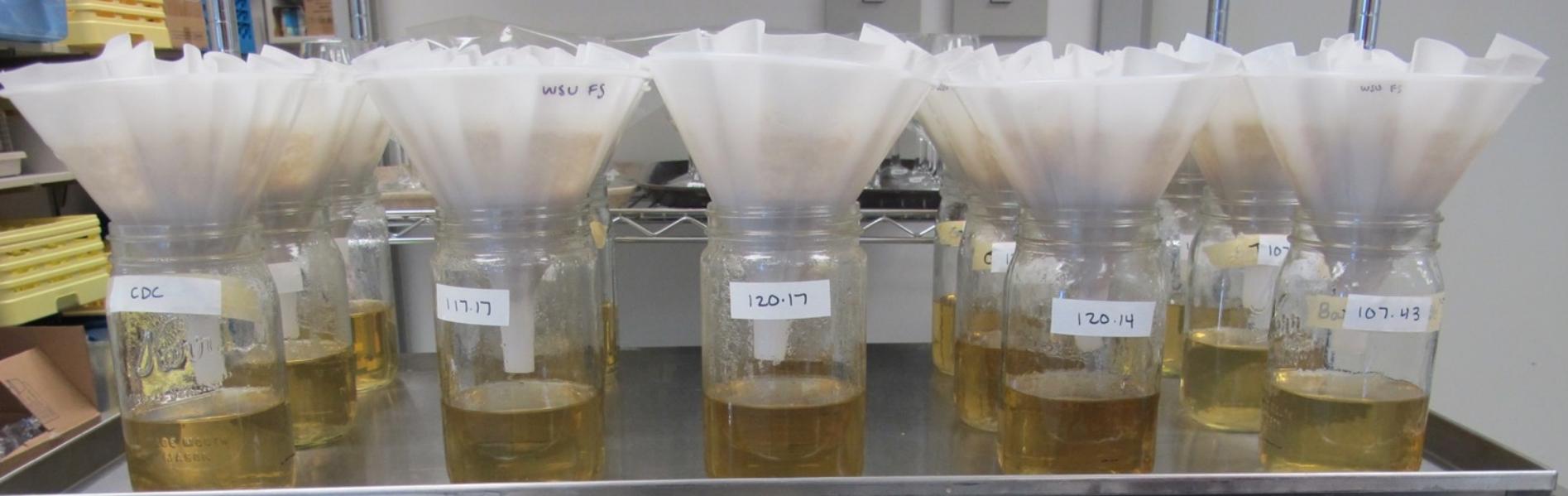
# Thank you!



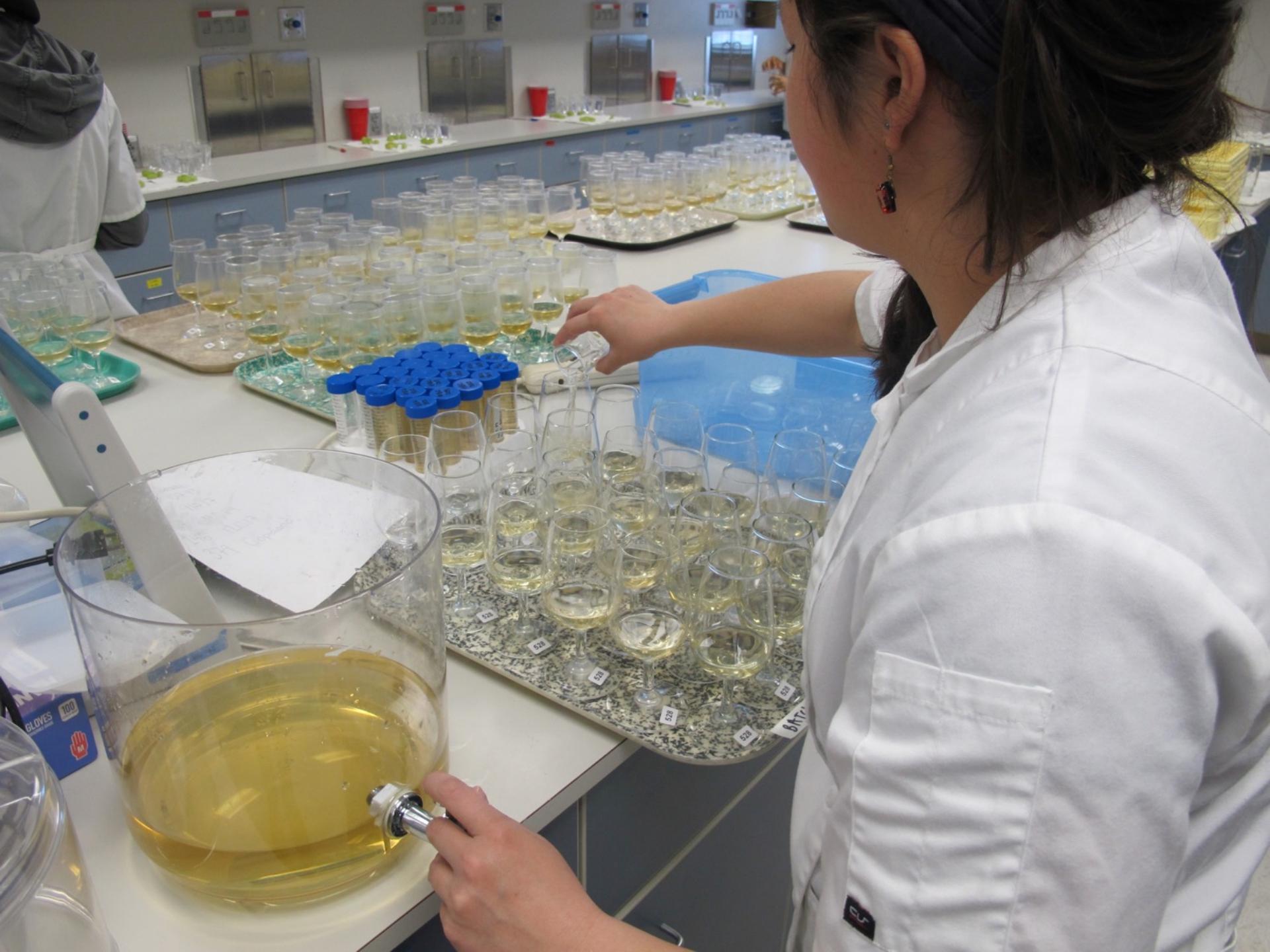
Images by Evan Craine

**Extra Slides Below**



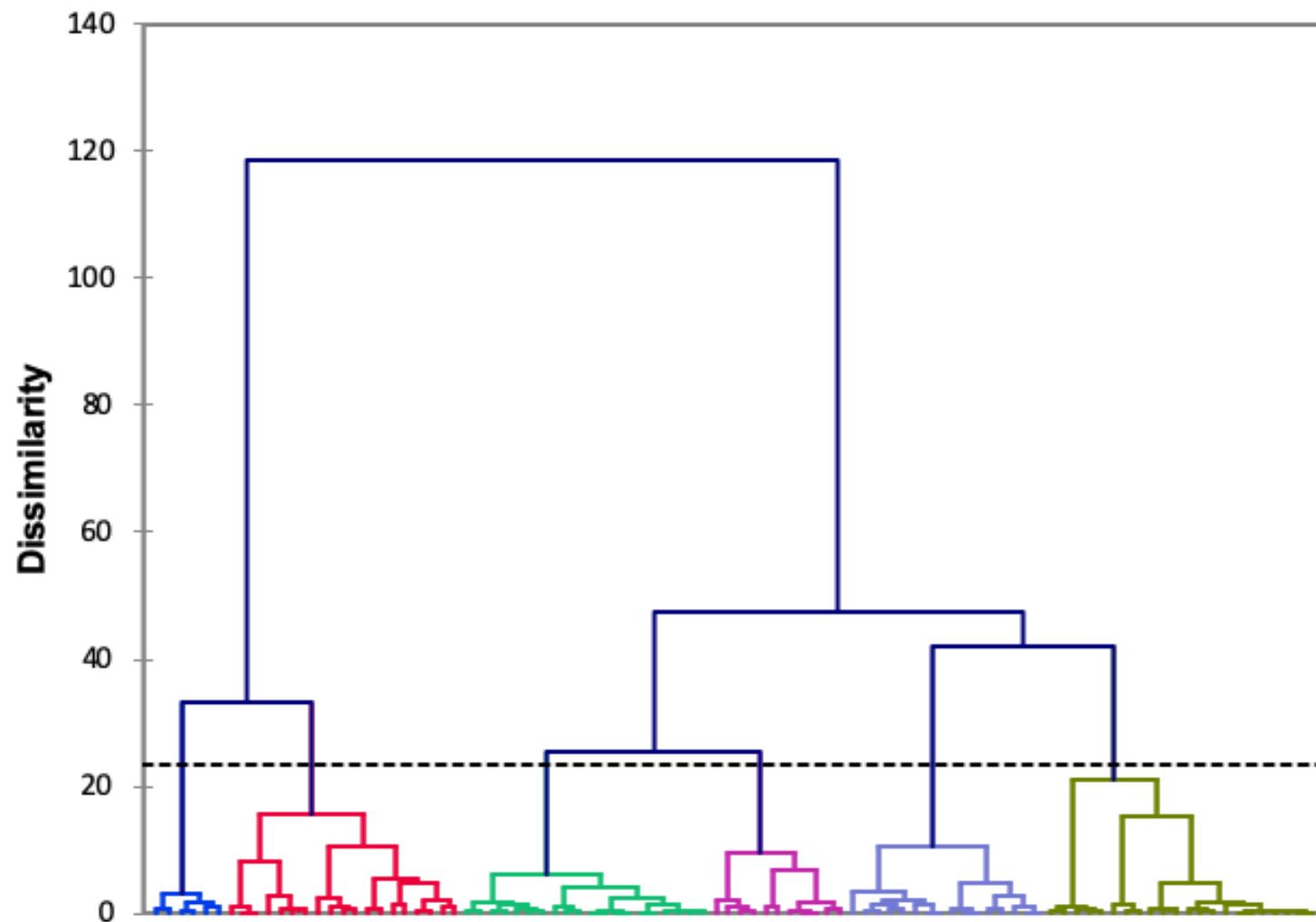




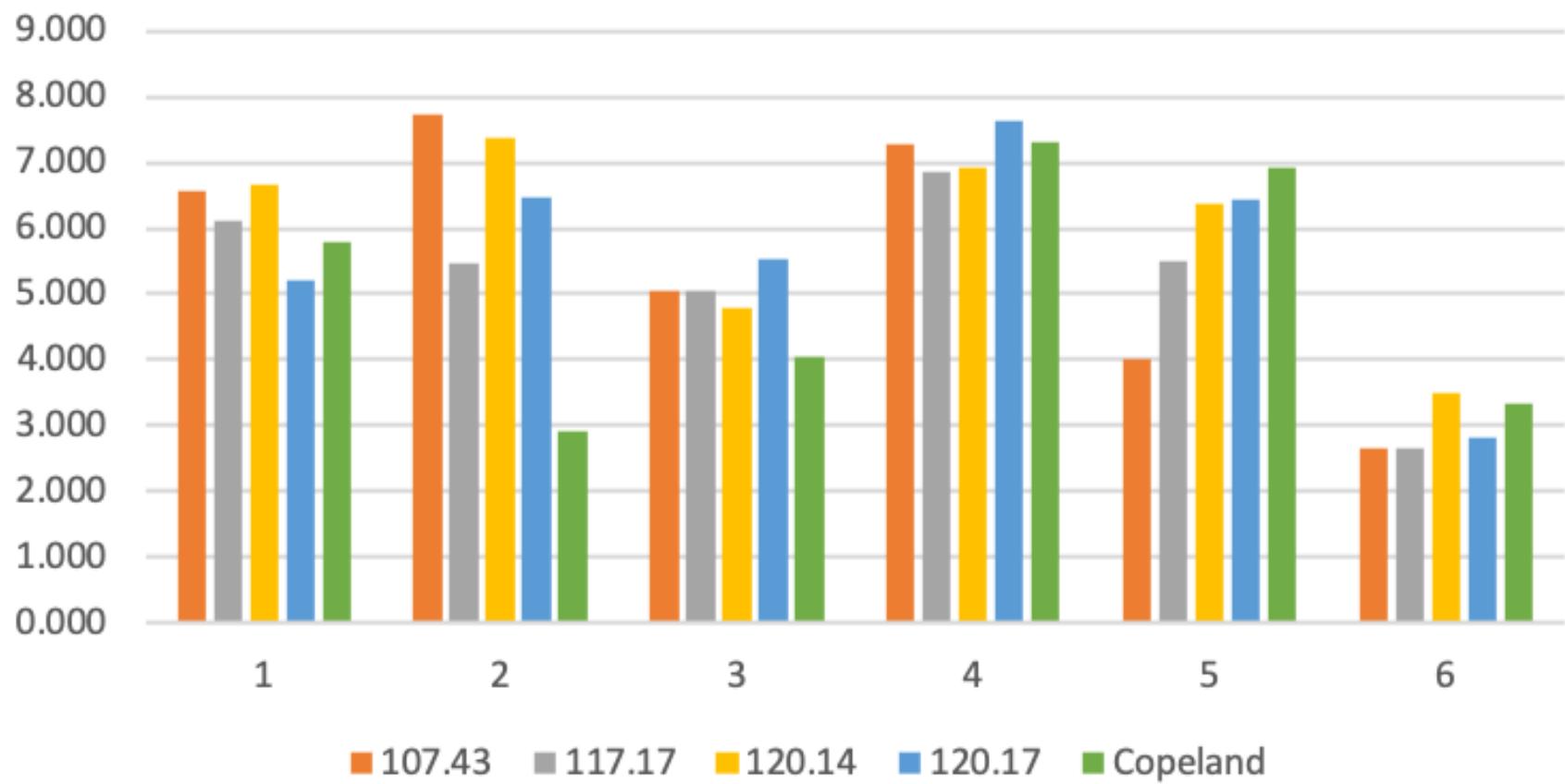




### Dendrogram



## Consumer Cluster Preferences



**Table 21.** Check All That Apply (CATA) scores for main attributes describing hot steep malt samples (n=95).

<b>Attributes</b>	<b>107.43</b>	<b>117.17</b>	<b>120.14</b>	<b>120.17</b>	<b>CDC</b>
Bready	28.42%	33.68%	30.53%	32.63%	28.42%
Breakfast Cereal	37.89%	29.47%	37.89%	30.53%	31.58%
Earthy	42.11%	40.00%	31.58%	35.79%	34.74%
Floral	15.79%	20.00%	18.95%	26.32%	15.79%
Fruity	12.62%	13.68%	5.26%	15.79%	20.00%
Grainy	60.00%	60.00%	68.42%	57.89%	57.89%
Grassy	50.53%	55.79%	60.00%	52.63%	52.63%
Honey	46.32%	41.05%	41.05%	42.11%	49.47%
Nutty	23.16%	26.32%	25.26%	32.63%	32.63%
Stale	16.84%	22.11%	12.63%	17.89%	13.68%
Other	1.05%	2.11%	7.37%	2.11%	1.05%

## HOT STEEP: ATTRIBUTE DIFFERENCES AMONG SAMPLES

Attributes	107.43	117.17	120.14	120.17	Copeland
Bready	0.284 (a)	0.337 (a)	0.305 (a)	0.326 (a)	0.284 (a)
BreakfastCer	0.379 (a)	0.295 (a)	0.379 (a)	0.305 (a)	0.316 (a)
Earthy	0.421 (a)	0.400 (a)	0.316 (a)	0.358 (a)	0.347 (a)
Floral	0.158 (a)	0.200 (a)	0.189 (a)	0.263 (a)	0.158 (a)
Fruity	0.126 (ab)	0.137 (ab)	0.053 (a)	0.158 (ab)	0.200 (b)
Grainy	0.600 (a)	0.600 (a)	0.684 (a)	0.579 (a)	0.579 (a)
Grassy	0.505 (a)	0.558 (a)	0.600 (a)	0.526 (a)	0.526 (a)
Honey	0.463 (a)	0.411 (a)	0.411 (a)	0.421 (a)	0.495 (a)
Nutty	0.232 (a)	0.263 (a)	0.253 (a)	0.326 (a)	0.326 (a)
Stale	0.168 (a)	0.221 (a)	0.126 (a)	0.179 (a)	0.137 (a)
Other	0.011 (a)	0.021 (ab)	0.074 (b)	0.021 (ab)	0.011 (a)

*Multiple pairwise comparisons using the Critical difference (Sheskin) procedure*

**Table 28.** Check All That Apply (CATA) scores for main attributes describing beer samples (n=95).

Attributes	107.43	117.17	120.14	120.17	CDC
Butter	11.58%	17.89%	14.74%	13.68%	7.37%
Cereal	27.37%	21.05%	31.58%	28.42%	26.32%
Chemical	28.42%	40.00%	22.11%	37.89%	32.63%
Citrus	36.84%	22.11%	21.05%	23.16%	24.21%
Earthy	21.05%	21.05%	26.32%	29.47%	42.11%
Floral	23.16%	28.42%	27.37%	24.21%	22.11%
Fruity	24.21%	27.37%	30.53%	16.84%	14.74%
Grassy	23.16%	20.00%	14.74%	17.98%	30.53%
Nutty	18.95%	12.63%	15.79%	15.79%	18.95%
Stale	13.68%	8.42%	11.58%	14.74%	22.11%
Sweet aromatic	22.11%	33.68%	41.05%	24.21%	16.84%
Yeasty	36.84%	34.74%	35.7% <sup>9</sup>	43.16%	34.74%
Other	3.16%	10.53%	6.32%	4.21%	8.42%

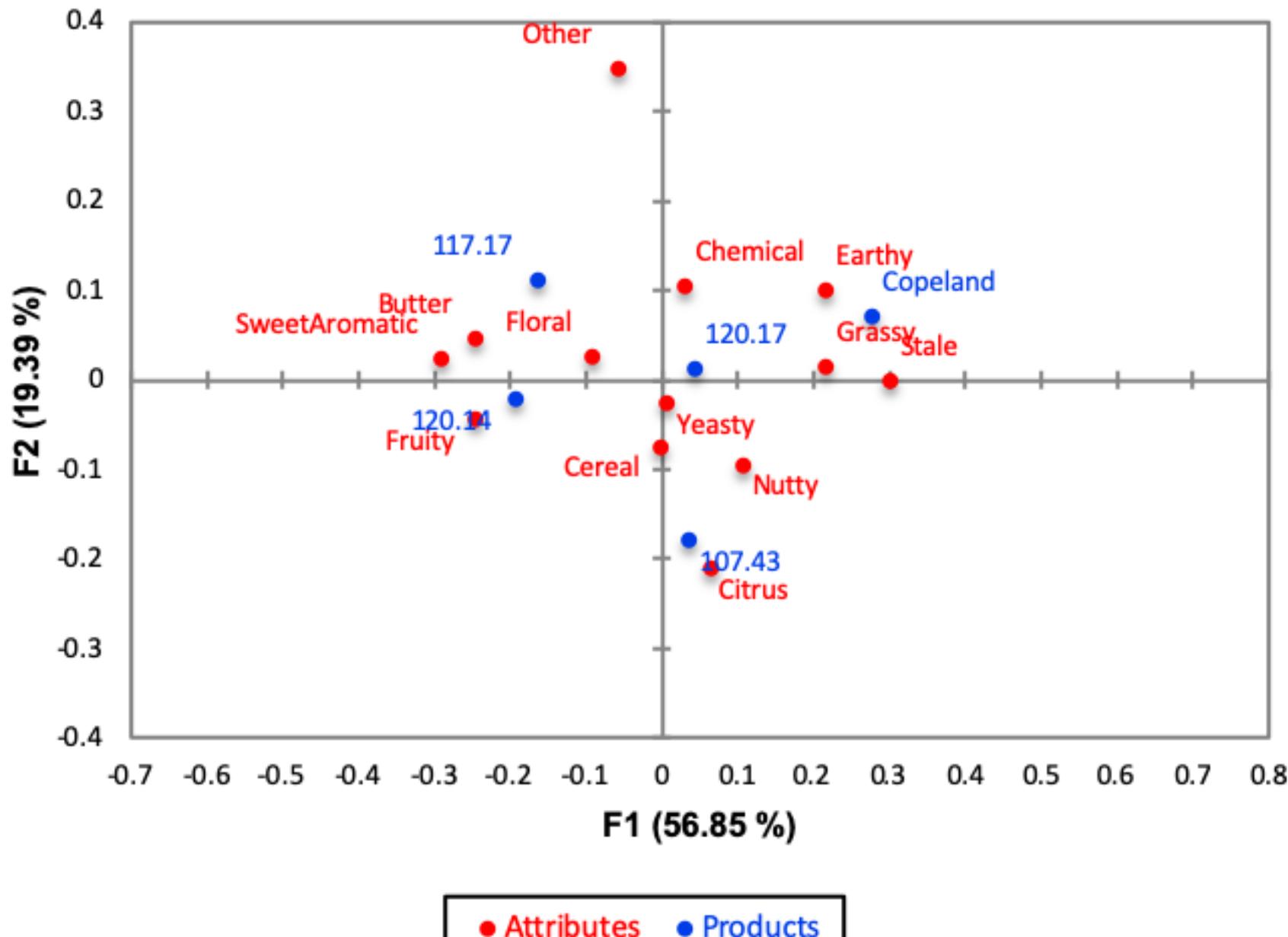
## BEER: ATTRIBUTE DIFFERENCES AMONG SAMPLES

Attributes	107.43	117.17	120.14	120.17	Copeland
Butter	0.117 (a)	0.181 (a)	0.149 (a)	0.138 (a)	0.074 (a)
Cereal	0.277 (a)	0.213 (a)	0.319 (a)	0.287 (a)	0.266 (a)
<b>Chemical</b>	0.287 (ab)	0.404 (b)	0.223 (a)	0.383 (b)	0.330 (ab)
<b>Citrus</b>	0.362 (b)	0.213 (ab)	0.202 (a)	0.223 (ab)	0.234 (ab)
<b>Earthy</b>	0.213 (a)	0.213 (a)	0.266 (ab)	0.298 (ab)	0.426 (b)
Floral	0.234 (a)	0.287 (a)	0.277 (a)	0.245 (a)	0.223 (a)
<b>Fruity</b>	0.234 (ab)	0.277 (ab)	0.309 (b)	0.170 (ab)	0.149 (a)
<b>Grassy</b>	0.234 (ab)	0.202 (ab)	0.149 (a)	0.181 (ab)	0.309 (b)
Nutty	0.191 (a)	0.128 (a)	0.160 (a)	0.160 (a)	0.191 (a)
<b>Stale</b>	0.138 (ab)	0.085 (a)	0.117 (ab)	0.149 (ab)	0.223 (b)
<b>SweetAroma</b>	0.223 (a)	0.330 (ab)	0.415 (b)	0.245 (a)	0.170 (a)
Yeasty	0.372 (a)	0.351 (a)	0.362 (a)	0.436 (a)	0.351 (a)
Other	0.032 (a)	0.106 (a)	0.064 (a)	0.043 (a)	0.085 (a)

*Multiple pairwise comparisons using the Critical difference (Sheskin) procedure*

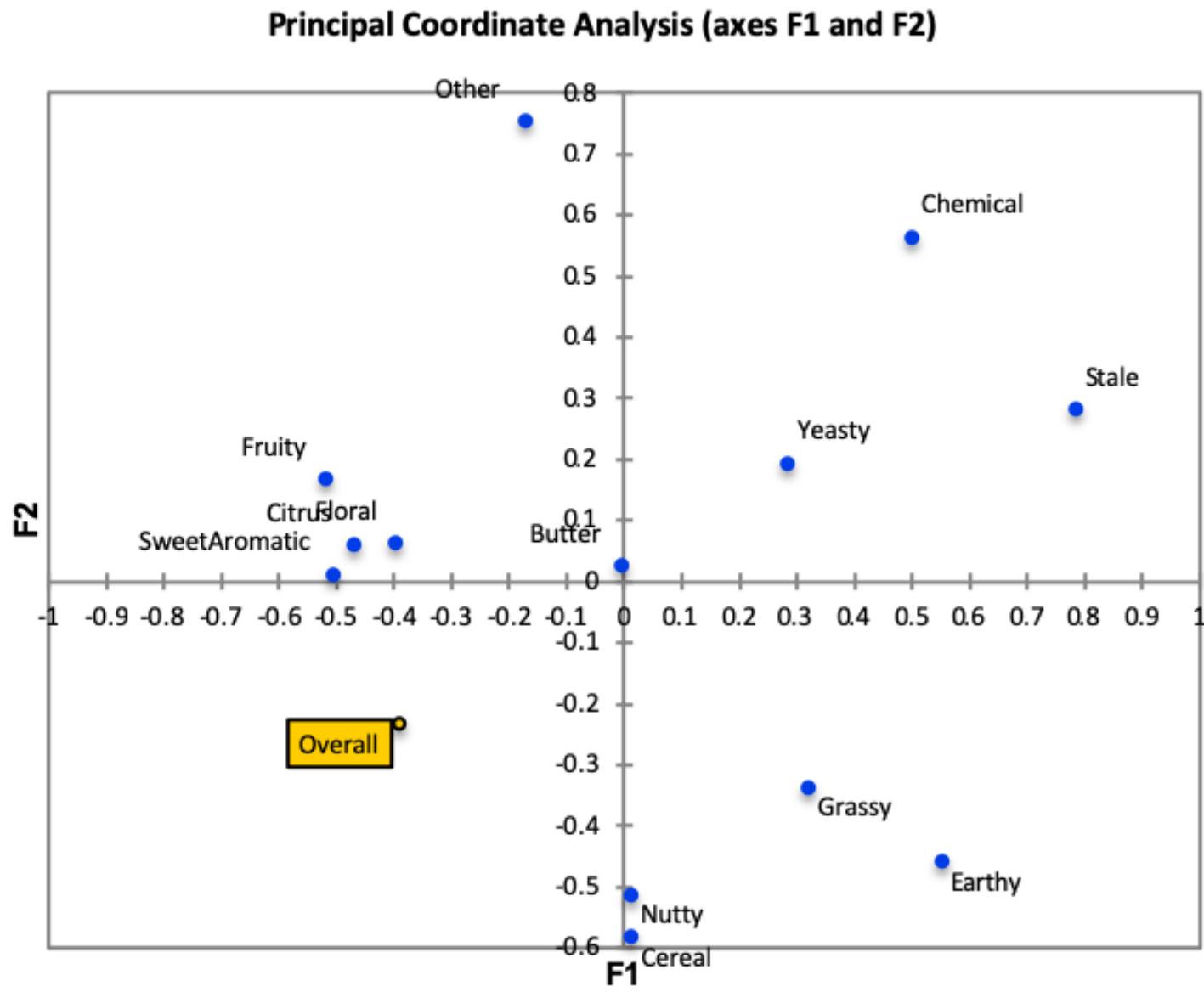
# BEER: CORRESPONDENCE ANALYSIS (ALL)

(axes F1 and F2: 76.24 %)



● Attributes   ● Products

# BEER: ALL ATTRIBUTES & OVERALL LIKING



# Hot Steep: “Other” Comments

Comment	Sample	Participant
Animal	120.14	52
Barn	120.17	28
bitter	120.14	1
hay	117.17	78
hay	120.14	78
hay	120.17	78
hey, reminds me of a barn hint of vegetable-kale or spinach	CDC-COPELAND 120.14	78 7
kinda tastes like green tea	120.14	32
metallic	117.17	49
Metallic	120.14	59
mushroom	120.14	53
mushroomy	107.43	53
tastes like chewing raw grain	120.14	57

## CDC-Copeland

*“This one is a barnburner. Hints of purple lilacs and sweet grass. Floral in a quiet, unassuming, noncombative way. Could drink this one all night.”*



120.17

*“It harkens to memories of a spring garden during potato planting season. The birds are chirping and the dew is light.”*

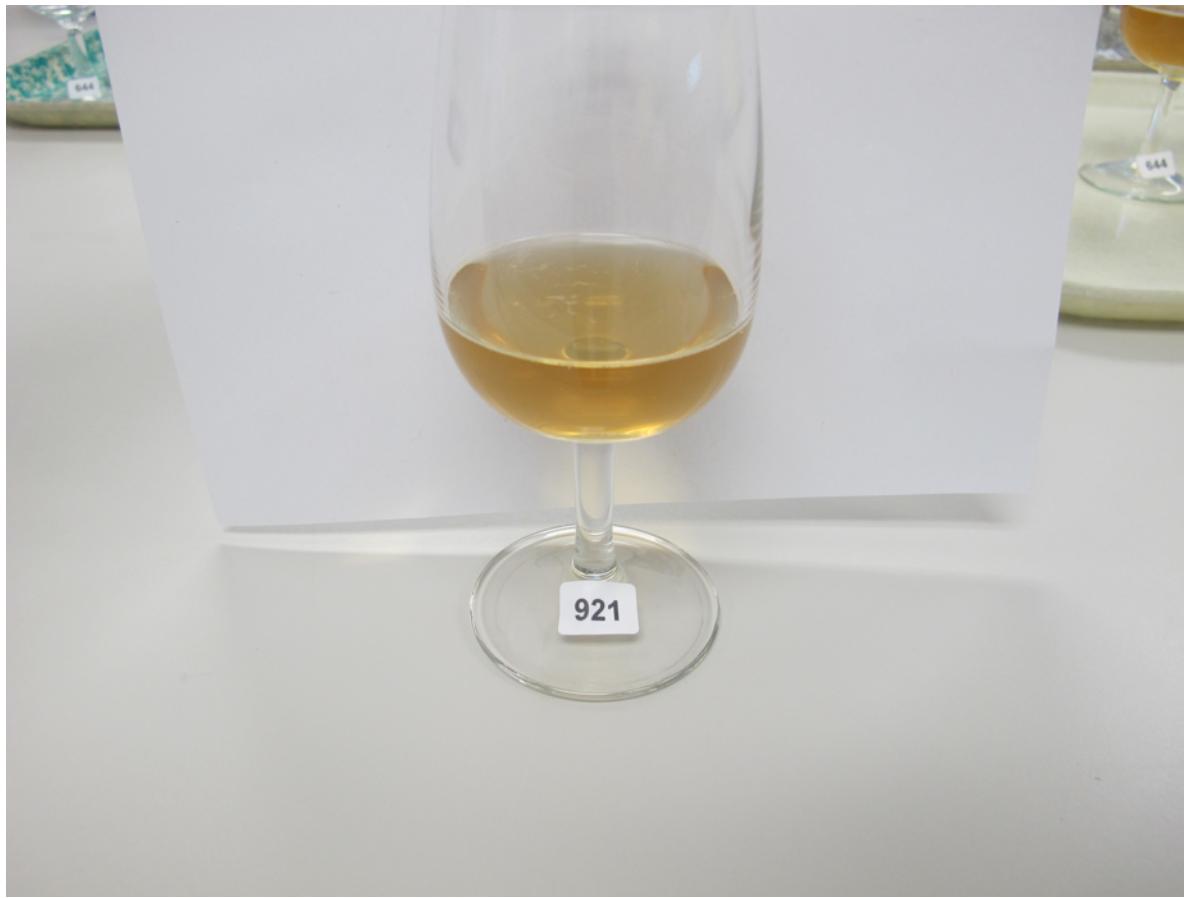


**120.14**

*“Full bodied and chewy. A slight sweet dulcet undertone wraps itself around the bitter backdrop of Oregon grape and they hold hands as they run singing through a field of oxeye daisies.”*



117.17  
*“Ballad of a thin man”*



107.43

*“Hmmm. This one started strong but left an astringency in the back of my tongue that was akin to licking a freshly dug beet.*

*Not bad, but not something I'd pursue in my free time.”*



# PALMER BARLEY



"This was a nicely balanced beer. It hit my palette in a pleasant sequence and provided a well rounded flavor."

.... good balance of bitter to sweet to draw me back to a summer beer. There are fruit and floral notes but not on the citrus end of the spectrum. Perhaps some nutty is present but not excessive. Again, perhaps a bit more malt than a fruit."

"The beer was more aromatic and had more complex flavors. It also had a little bitterness on the finish that I liked."

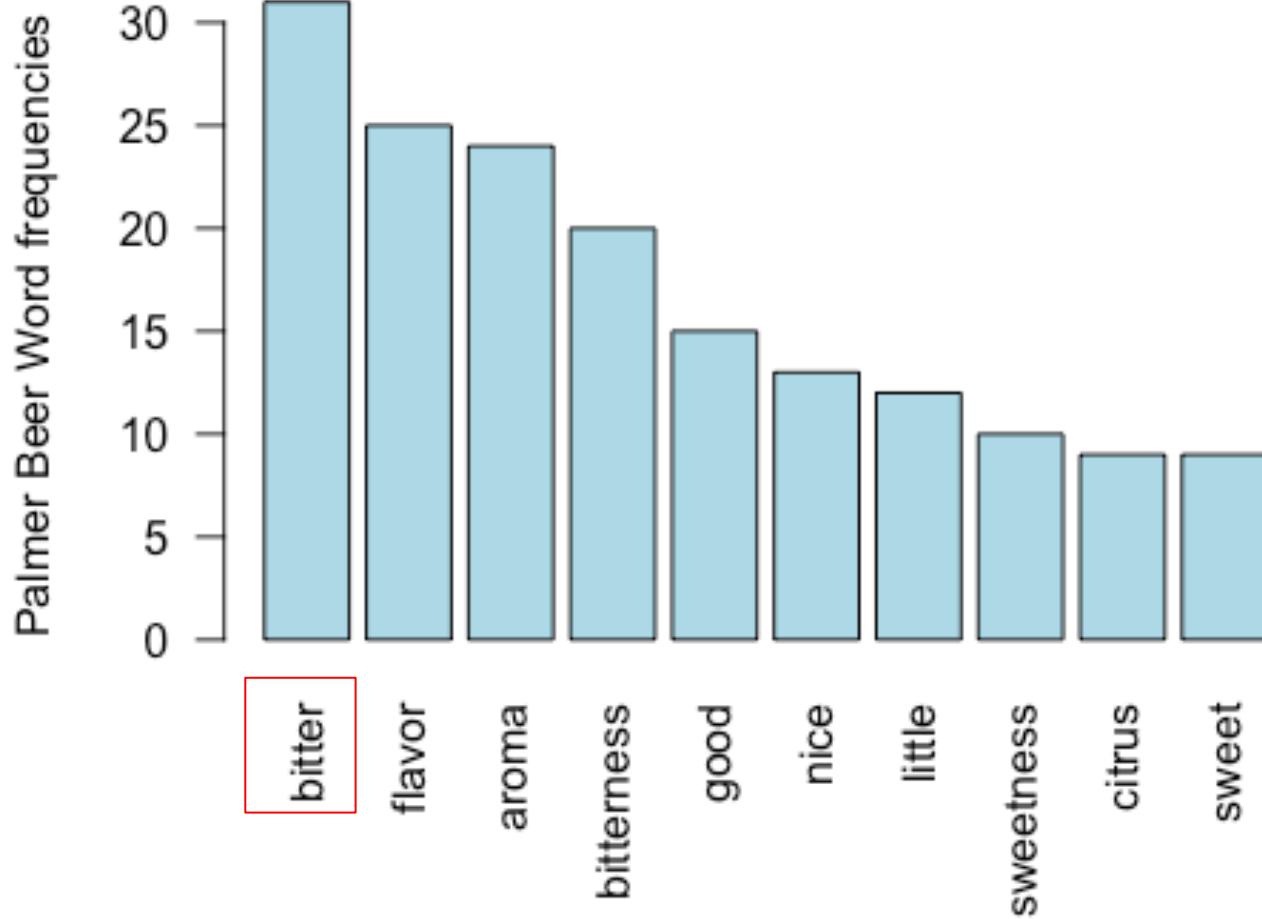
"I really enjoyed the pleasant fruity / citrus aroma. I was pleasantly surprised that I liked how bitter the beer tasted. It was layered with a sweetness that made the beer very pleasant"

nothing hoppy color  
good bit tasted  
flavor floral citrus  
nice level great  
sweet aftertaste pretty  
fruity little  
liked beer smell  
little strong  
Beer

samples stale subtle  
grainy seemed  
aroma  
flavorful  
grassy  
flavors  
sweet quite  
flavor earthy good  
taste bitterness  
sweetness nice  
strong balanced  
mild

Malt

## Most frequent Palmer Beer words



**“Balance” = 0.37**  
**“Heavily” = 0.35**

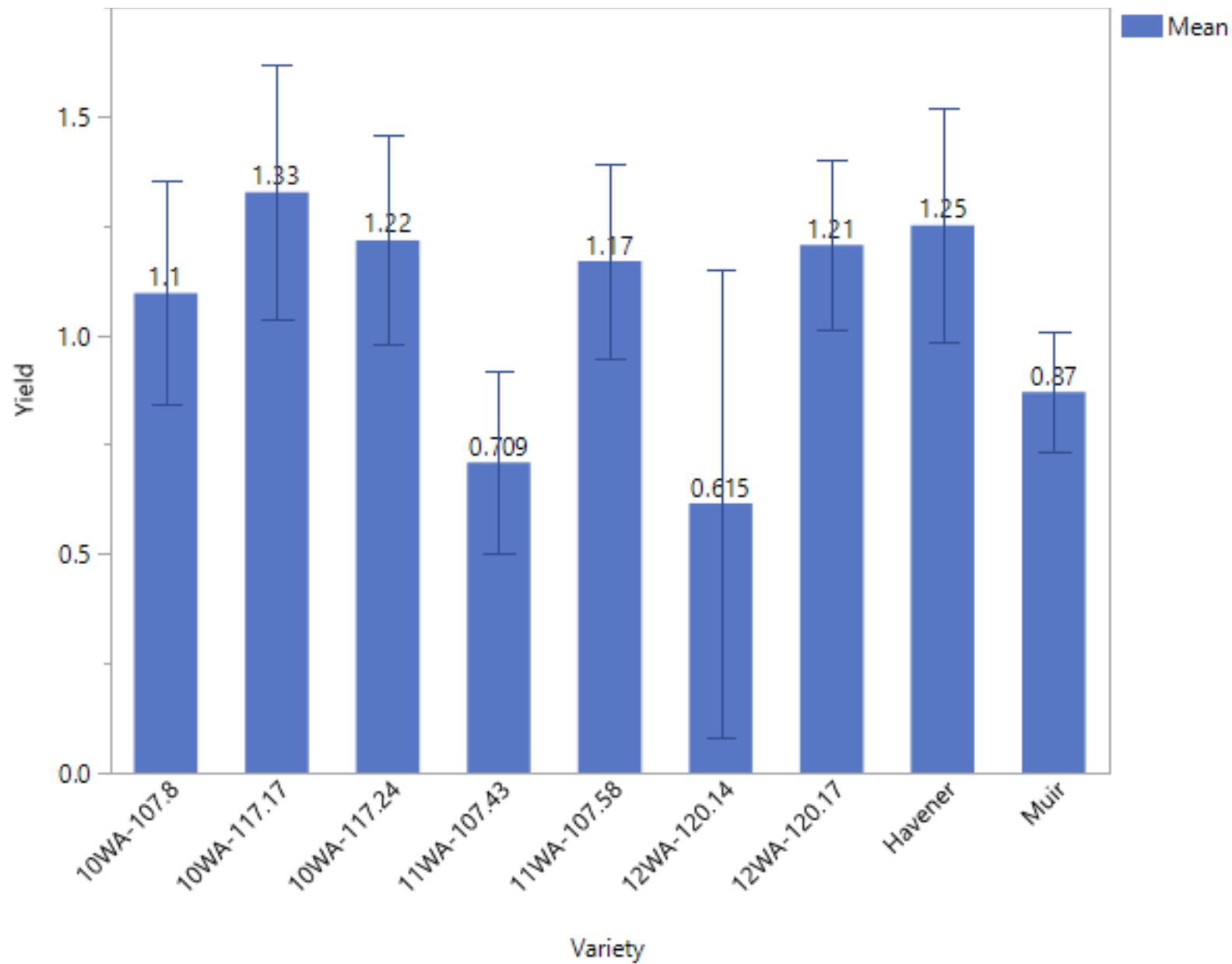
Entry	Brewhouse Efficiency (%)
Copeland	73.3
120.17	90.82
120.14	78.17
117.17	82.76
107.43	76.56











Each error bar is constructed using 1 standard deviation from the mean.

# 2017 Trial Malt Quality Generalized Steeping Regime

	Fine extract (% DB)	Friability (%)	B-Glucan (ppm)	S/T (%)	FAN (mg/L)	DP (°L.)
BA* Targets	>80.0	>85	<140	<45	<150	<150
Copeland	81.9	92	75	49.9	232	131
107.43	82.4	89.2	471	40.8	157	86
120.14	81.7	88.8	195	47.5	217	98
120.17	81.1	89	228	45	202	98
117.17	80.6	92.4	340	40.7	156	94
117.24	78.8	70.9	730	37.5	138	90
107.58	80.3	69.8	483	39.2	164	87
107.8	83.6	70.1	622	41.4	171	76
Havener	89.1	63.8	726	41.9	149	67
Muir	80.3	82.0	216	41.3	153	101

## 2017 Trial Malt Quality Modified Malting Regime

	Fine extract (% DB)	Friability (%)	B-Glucan (ppm)	S/T (%)	FAN (mg/L)	DP (°L.)
BA* Targets	>80.0	>85	<140	<45	<150	<150
Copeland	81.3	87.5	85	44.4	193	122
107.43	81.5	87.9	95	37.7	155	101
120.14	81.5	86.1	127	44.7	208	102
120.17	80.9	84.4	130	42.4	190	100
117.17	79.5	89.1	99	40.9	151	106

# 2017 Trial

## CCRU Malt Quality Analysis

Table UU. Malt Quality Analysis for 2017 Barley Trial

	All Malt Quality Score	Adjunct Score	Fine extract (% DB)	B-Glucan (ppm)	S/T (%)	FAN (mg/L)	DP (°L.)
11WA-107.43	42.0 a	44.7 ab	82.4 b	391.6 bc	53.4 cd	174.7 bc	82.5 ab
Muir	34.0 ab	44.3 a	80.0 e	126.5 d	54.9 bcd	182.0 b	91.2 a
12WA-120.14	33.3 ab	43.3 a	81.9 bc	288.3 c	63.4 a	220.5 a	64.9 bc
10WA-107.8	32.7 ab	44.3 a	82.3 b	660.6 a	54.2 bcd	158.1 cd	71.9 abc
10WA-117.17	30.7 b	38.0 b	80.5 de	462.1 b	55.4 bcd	151.9 cde	77.6 abc
12WA-120.17	30.0 b	44.0 a	81.1 cd	300.5 c	60.5 ab	193.3 b	78.8 bc
11WA-107.58	28.3 b	44.0 a	81.1 cd	406.8 bc	56.7 bc	186.9 b	66.8 bc
Havener	28.3 b	38.0 b	87.8 a	725.4 a	60.3 ab	148.5 de	58.5 c
10WA-117.24	26.0 b	31.0 b	79.7 e	700.6 a	49.0 d	129.4 e	78.8 ab

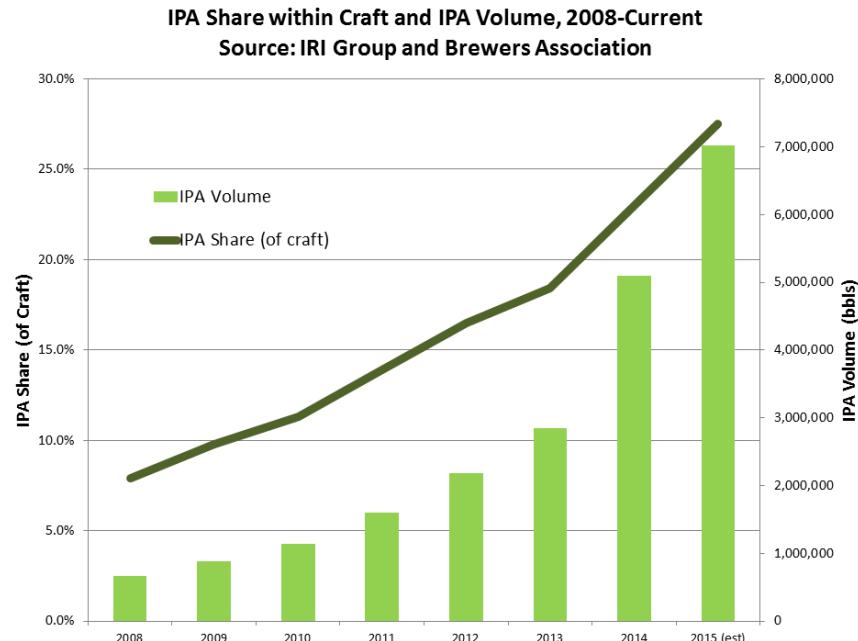
\*Significant differences ( $p<0.05$ ) in sample means analyzed using Tukey Pairwise Comparison

# CRAFT BEER: THE IPA

## India Pale Ale or *Immediate Profit Ahead*

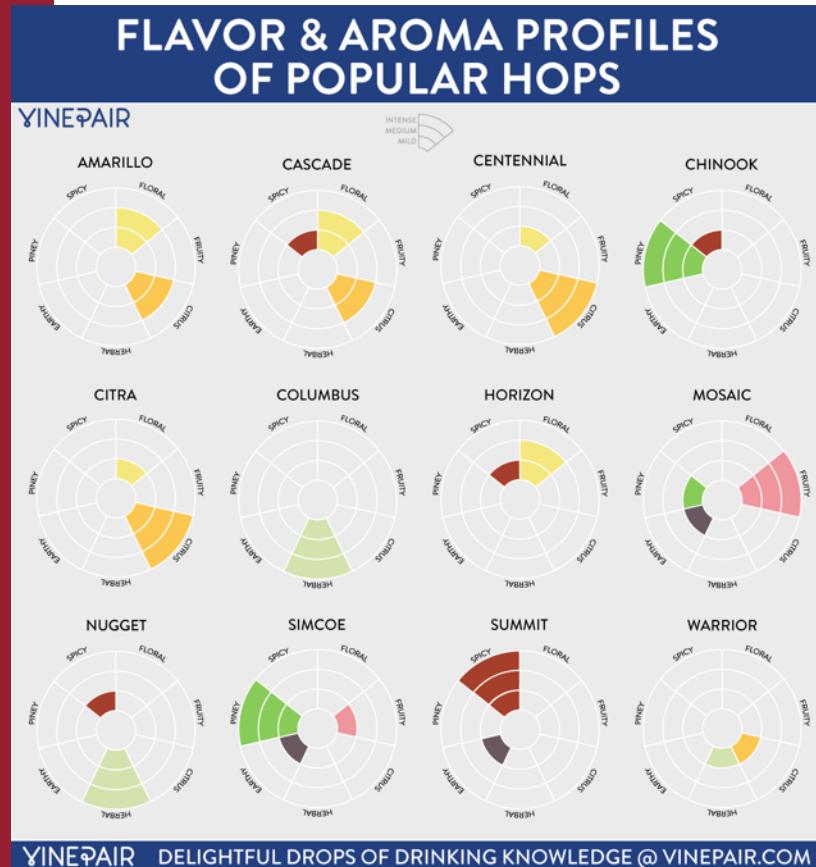
- 50/50 to 80/20 production of aroma to bitter hops
- Production and acreage increased 77% and 79.5% since 2012, respectively
- U.S. now world's leading hop producer

(Hop Growers of America, 2018)



Brewers Association, 2015

# HOP VARIETAL RECOGNITION



<https://vinepair.com/features/external/types-of-hops-infographic.png>



<https://static1.squarespace.com/static/5386bf34e4b0f6a71c87ce6a/59aedb5cff7c5054b51780b4/5b6cb4e440ec9ad5dd96e651/1533920779276/FBC-Field-to-Ferment-bottle-lineup-2018.png?format=2500w>