70

2014 ASBC Annual Meeting

Influence of hop regime, cultivar and yeast on hop aroma in beer using descriptive sensory analysis

Daniel C. Sharp, Gina Shellhammer, and Thomas H. Shellhammer

Dept. of Food Science and Technology, Oregon State University

75th ASBC Annual Meeting
June 4–6, 2014
Palmer House, a Hilton Hotel
Chicago, IL

Introduction

For centuries brewers have used hops (*Humulus lupulus* L.) to impart aroma and flavor to beer through the coordination of the physical, chemical and biochemical phenomena that occur during brewing. Physical factors include brewing conditions, such as heat and time, that preferentially extract the unique chemical composition of each hop cultivar. Biochemically, it has been suggested that yeast possess the ability to biotransform hop derived compounds, such as glycosidically bound terpene alcohols into their aroma active aglycones. The goal of this study was to investigate the effects of the physical, chemical, and biochemical factors mentioned above on the hop aroma properties of beer. This study is part of multiphase project aimed at modeling hop aroma in beer.

Objectives

- Identify and quantify hop derived aroma produced by different hopping methods, yeasts, and cultivars using sensory analysis techniques.
- Provide sensory directed insight for future instrumental analysis and model development.

Materials and Methods

Beer Production

Mash/Wort production
- 98 % pale ale malt, 2% acidulated malt
- Single infusion mash (20°P)→(12ºP)

Hop Treatments

Cultivars – Hallertau MF (HHA) or Simcoe Pellets
- Control – 25 ppm isohop™ 60 min boil
- Kettle (KH): 1.5 g/l hop pellets, 60 min boil
- Whirlpool (WP): 25 ppm isohop™ + 1.5 g/L pellets
  - 10 min whirlpool rest
- Dry hop (DH): 25 ppm isohop™ + 1.5 g/L pellets
  - 19 C for 48 hours

Fermentation and storage
- 40 liter ferments, OG = 12°P
  - Ale yeast - 19°C, 6-7 days
  - Lager Yeast - 19°C, 12 days
  - Cold storage at 1°C (2 weeks)

Filtration and packaging:
- Sheet filtration
- 1.6 volumes CO_2
- Kegged and bottled

Beer Analysis

Original gravity, real extract, color, alcohol %(v/v) Iso-alphas and alphas by HPLC and Bitterness units were all measured for all beers using ASBC standard methods.

Aroma Analysis

Panel Composition
- Trained daily for 2 weeks.
- 12 Panelists
- Ages 21-63, avg.= 39
- 9 male, 12 female

Difference Testing
- Triangle tests:
  - KH vs. Control
  - Brew Rep 1 vs. Brew Rep 2

Descriptive Analysis
- Randomized blocks (yeast)
  - 6 reps
  - Orthonasal aroma
  - 0-7 Scale

Consensus Derived Sensory Descriptors Reference Standards

Term	Definition	Reference Composition
Overall intensity	Total combined aroma intensity	NA
Pine/Resinous	Coniferous woody aroma. Tree sap/pitch.	75 µl α-pinene + 75 µl β-pinene + 25µL myrcene + 5µL hexanoic acid + 75 µl carophyllene oxide + 75 µl thujamber + 2.5 µl isothymol
Grassy/Hay	Fresh cut grass or dried grass	75 µl myrcene + 75 µl cis-3-hexanol
Herbal	Oregano, basil or similar spice	75 µl α-humulene + 10 µL eugenol
Floral	Geraniums, roses, orange blossom, sweet bouquet, or potpourri	150 µl linalool + 10 µL phenyl ethanol + 10 µL eugenol
Citrus	Lemon, orange, grapefruit, mandarin peel or juice	75 µl 10% limonene + 10% 75 µl + 10% citral + 25 µl 100% citronellol
Stone Fruit	Peach, cooked fruit, apricot, nectarine	150 µl γ-decalactone
Tropical Fruit	Guava, pineapple, sweaty, dank(cannabis-like), papaya, passion fruit, pear.	75 µl ethyl isobutarate, 75 µl 3-carene, 25 µL citronellol, 5 µl hexanoic acid, 0.5 µl dibutyl sulfide , 5 µl 0.01% 3MHA
Cooked Cabbage/ Vegetable	Savory vegetable like aroma. Cooked cabbage, but not DMS. Garlic like.	60 µl humulene epoxide, 5µl 100% α-phellandrene, 2µl isothymol, 5 µl ethyl isopropyl sulfide

Results

Brewing

Average Beer Specs by Yeast

Parameter	Yeast	
	Ale	Lager
Original Gravity (P)	13	13
StDev	-	-
Real Extract	4.58	4.86
StDev	(0.10)	(0.11)
Color (SRM)	8.42	7.92
StDev	(0.20)	(0.29)
Alcohol (%v/v)	5.58	5.40
StDev	(0.06)	(0.07)

Average hop acids measurements in beers by hop treatment

Parameter	IsoHop	HHA			Simcoe		
	Cont.	KH	WP	DH	KH	WP	DH
Iso-α (ppm)	27.1	16.7	23.3	23.9	33.3	29.55	20.4
StDev	(4.0)	(1.9)	(4.8)	(1.8)	(1.4)	(3.3)	(0.6)
BU	30.2	20.5	23.6	22.1	36.7	35.0	20.0
StDev	(8.4)	(2.0)	(5.0)	(2.1)	(2.1)	(2.4)	(2.2)
α-acids (ppm)	ND	2.6	1.7	2.1	4.4	7.3	2.1
StDev	(ND)	(0.7)	(1.6)	(0.7)	(0.5)	(0.5)	(0.3)

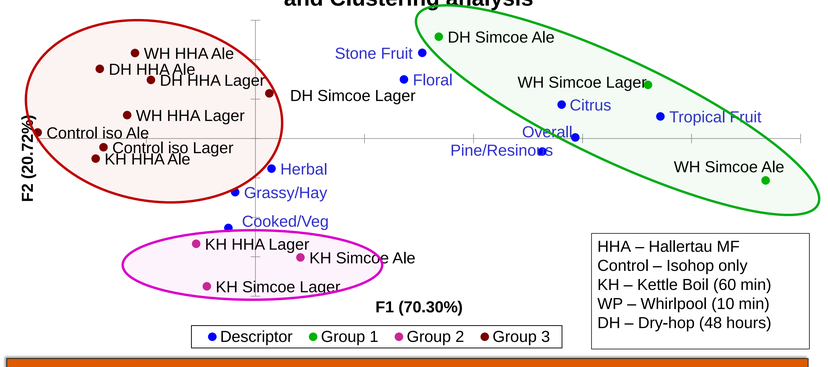
Sensory

ANOVA F-statistics for Descriptive panel full model

Source	Overall	Pine/ Resin	Grassy/ Hay	Herbal	Floral	Citrus	Stone Fruit	Tropical Fruit	Cooked/ Vegetative
Treatment	**13.531**	**6.632**	**6.833**	**6.271**	**7.522**	**14.559**	**14.441**	**8.939**	**14.252**
Hop	**47.949**	**43.424**	0.204	**3.980**	2.182	**22.125**	3.027	**32.970**	1.275
Yeast	0.449	0.165	1.474	1.090	0.201	0.781	0.002	1.974	**6.830**
Treatment*Hop	**7.997**	**9.670**	0.573	0.103	1.794	**8.047**	**3.340**	**6.834**	1.262
Treatment*Yeast	0.682	0.328	0.770	1.020	1.512	1.579	0.593	0.194	0.333
Hop*Yeast	1.723	1.769	0.351	0.068	1.369	1.550	0.290	3.067	0.581
Treatment*Hop*Yeast	0.175	0.843	1.520	0.788	0.907	0.073	2.611	1.681	0.954

Bold = Statistically significant p<0.05

Principle Component Analysis (91.02%) and Clustering analysis



HHA – Hallertau MF
Control – Isohop only
KH – Kettle Boil (60 min)
WP – Whirlpool (10 min)
DH – Dry-hop (48 hours)

Conclusions

- Significant difference in sensory attributes were driven mainly by a hop by treatment interaction and hop addition interaction effects (p-value <0.05)
- Beers hopped with Simcoe had higher Overall, Tropical Fruit, Citrus, Stone Fruit and Pine aroma intensities.
- Kettle hopping treatments were associated with cooked/veg, grassy, and herbal notes.
- Yeast had the least effect on aroma.

Contact:

Daniel Sharp – daniel.sharp@oregonstate.edu
Tom Shellhammer – tom.shellhammer@oregonstate.edu