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A Comparison of Quality : Freeze dried vs. Kiln dried Cascade hops

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INTRODUCTION

Kiln drying hops after cultivation impacts the flavor quality of the hop material. Factors such as heat, oxidation, and time effect the chemical composition of hop acids and hop oils (***1***). It has been demonstrated that a kilning temperature difference of 20 F (130 F vs. 150 F) can create hops with notably different sensory qualities, hop oil compositions, and Hop Storage Index [HSI] values (***2***). Freeze drying is a low temperature, reduced atmosphere, method of drying. The purpose of this research was to examine the effects of freeze drying hops as opposed to conventionally kiln drying hops, and to compare the flavor quality of the resulting hops in dry hopped beer.

METHODS

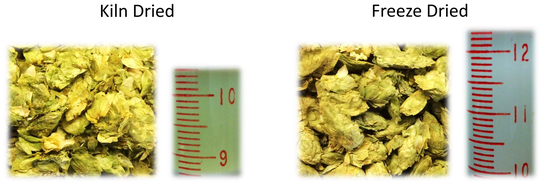
Cascade hops grown in Yakima, WA were harvested from a single plot and then both freeze dried and kiln dried. A 5kg proportion of the Cascade hops was freeze dried at Oregon State University, and the remaining Cascades hops were conventionally dried in a commercial kiln.

Brewing and Sensory Analysis was carried out in beer at John I Haas to determine the flavor impact of the hop drying methods. A single malt lager was brewed as a control beer, bittered with high alpha extract to 20 BUs. 40 liters of the lager was dry hopped with freeze dried Cascades and another 40 liters was dry hopped with kiln dried Cascades; both at the level of 5.7 g/L (1.5 lb/bbl). A 14 member trained panel used 10 descriptive terms to rate the aroma of the dry hopped beers.

GC analysis was performed at Oregon State University using the following method: Samples were ground and added by mass to amber GC vials. 0.5 grams of crushed hop material were added to 20 mL amber vials. Volatiles were measured on a HP6890/5972A GC-MSD (Agilent, Santa Clara, CA) using SPME in conjunction with a Gerstel Autosampler. The extraction was completed using a three phase (DVB/Carboxen/PDMS) 1 cm fiber (Supelco, Bellefonte, PA). Autosampler parameters incubated the crushed hop material at 50 °C for 50 minutes preceding an injection time for 10 minutes on the GC inlet. GC parameters were as follows: Split injection mode (1:25 ratio) using ultra-pure Helium as the carrier gas. Sample was injected on the 250 °C inlet for 10 minutes. Column attributes: Supelco HP-WAX (30m x 250 um x 0.5 nominal) with a flow rate of 1.3 mL/min. Oven program: (40 °C for 2 min, 5°C/min until 230 °C, hold for 10 minutes). Detection was completed via a Mass Selective Detector operating in scan acquisition mode.

GENERAL RESULTS

Figure 1. Differences in Quality: Hop Cones and Hop Oils



Freeze dried hop cones were more intact than the Kiln dried hop cones, and the Freeze dried hops produced substantially more oil per 100g (2.5ml vs 1.7ml). There was also a difference in oil color; the Kiln dried hop oil was much more yellow in color.

Figure 1. Appearance of Dry hopped Beers

The picture to the left is a snapshot from sensory analysis. The beer labeled 432 was dry hopped with Kiln Dried Cascades. The beer labeled 105 was dry hopped with Freeze Dried Cascades. The beers were nearly indistinguishable and added a similar haze quality to the beer.

INSTRUMENTAL RESULTS

Table 1. Hop Cone Instrumental Results

Sample	Oil (ml/100g)	Moisture (%)	Alpha (%)	Beta (%)	H.S.I.
Kiln Dried Cascade	1.7	8.1	7.2	6.0	0.33
Freeze Dried Cascade	2.5	3.2	7.4	6.4	0.26

Table 2. GC Analysis: Comparison of Hop Volatile Components

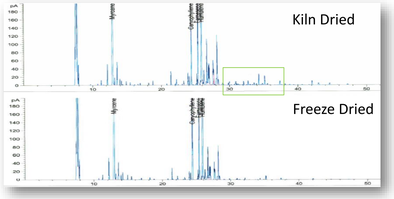
Compound	Kiln Dried (% mAU)	Freeze Dried (% mAU)
Beta Myrcene	64.0 +/- 0.58	67.2 +/- 0.85
Linalool	0.4 +/- 0.01	0.3 +/- 0.01
unknown 1	0.6 +/- 0.02	0.5 +/- 0.02
unknown 2	0.5 +/- 0.01	0.4 +/- 0.01
terpine-4-ol	6.0 +/- 0.04	5.0 +/- 0.22
Beta Farnesene	5.3 +/- 0.10	5.8 +/- 0.39
Alpha Humulene	12.5 +/- 0.05	10.7 +/- 0.75
unknown 5	0.3 +/- 0.00	0.2 +/- 0.01
unknown 6	0.8 +/- 0.01	0.7 +/- 0.04
Geranyl Acetate	1.1 +/- 0.02	1.1 +/- 0.03
Citronellol	0.5 +/- 0.02	0.4 +/-0.06
Caryophyllene Oxide	0.0	0.0

The values shown are the average % area +/- the standard deviation.

Denotes a statistically greater value.

The Freeze Dried hops contained a greater percentage of only Beta Myrcene. The Kiln Dried hops contained a greater percentage of most other identifiable volatile compounds, including oxidized compounds and terpenoids. The differences in volatile components were statistically significant, yet small in magnitude.

Table 2. GC Analysis: Comparison of Hop Oil Chromatograms



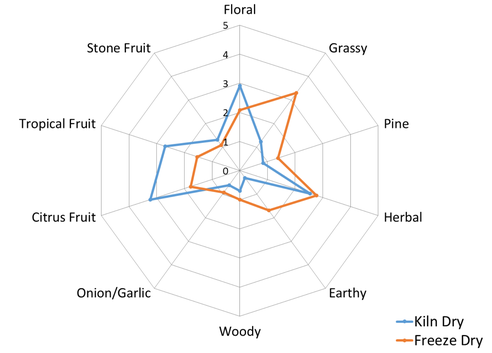
Depicts an area of unidentified compounds that were found in greater amounts in the Kiln Dried hop oil.

SENSORY RESULTS

Table 2. Triangle Test Results of the Dry Hopped Beers

Test Comparison	Sample Size	Correct	Significant?	Significance Level
Kiln vs. Freeze Dry hopped beers	14	10	Yes	p = 0.01

Figure 3. Descriptive Analysis of Dry Hopped Beers



CONCLUSION

Instrumental analysis showed the freeze dried Cascades contained substantially more oil than the kiln dried Cascades (2.5 ml per 100g vs. 1.6 ml per 100g) and had a lower HSI than the kiln dried Cascades (0.26 vs. 0.33). GC analysis of the hop cones indicated that the hops had significant differences in certain volatile components, although a similar profile overall.

Sensory Analysis indicated that the dry hopped beers were significantly different in sensory quality, which was evident in triangle testing (p=0.01, N=14). In descriptive analysis testing, the panel found the freeze dried beer to be significantly higher in *grassy* and *earthy* aromas, and the kiln dried beer to be significantly higher in *citrus* and *tropical fruit* aromas.

The low temperature and reduced atmosphere conditions of the freeze drying process produced hops with superior analytical properties; a higher oil content and lower HSI value. However, in sensory evaluation of the dry hopped beers, neither hop treatment was clearly superior in flavor, but rather different in quality. An area of interest for further research is the flavor maturation caused by kiln drying, and the aroma compounds responsible for this change.

1. Weber, K. A., Jangaard, N. O., and Foster, R. T. Effects of Post Handling on Quality and Storage of Cascade Hops. *J. Am. Soc. Brew. Chem.* 37(2):58-60, 1979.

2. Nielson, T. The effect of kilning air temperature on hop essential oil content and aroma. MBAA Conference Proceedings. O-44. Austin, Texas. 2013.