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Evaluation of First Wort Hopping

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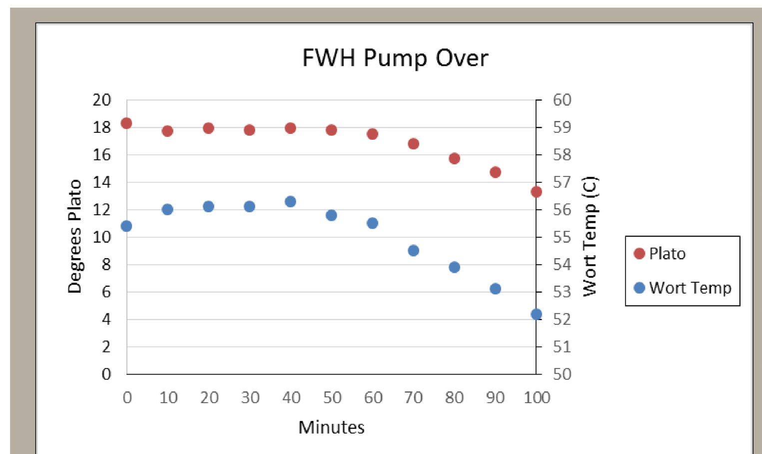
Introduction

Many factors influence the sensory perception of bitterness. Hop cultivar, processing techniques, age and storage conditions all contribute in their own unique way to the bitterness perceived by the beer consumer. The timing of hop additions to boiling wort in the brewing kettle is one well established factor. Time and temperature aid in the conversion of hops' non-bitter alpha acids into intensely bitter iso-alpha acids. Traditionally hops added to boiling wort early in the boil contribute more bitterness and less aroma to the finished beer. While hops added later in the process contribute more aroma and less bitterness to the end product. A variation on the traditional hopping regimen is first wort hopping (FWH). FWH is a technique where the first hop addition to the kettle is done pre-boil, before kettle full. This method exposes the hop material to wort at lower temperatures and a higher pH for an extended period of time. The technique is embraced by both industry and home brewers alike, but often for different reasons. Research related to FWH is limited and details surrounding the studies remain vague and anecdotal. Proponents of the technique suggest FWH produces a beer with improved bitterness qualities and use terms such as "smooth" or "harmonic" to describe its effects. Others believe that FWH also impacts a beer's hop aroma qualities, creating beers with improved aroma and an increase in overall hop aroma intensity. Research at the Oregon State University Pilot Brewery examined these claims.

Materials and Methods

Beer Production:

Two worts were prepared using a recipe designed to replicate the parameters of an American pale ale made with Cascade hops. The resulting brews differed only in the timing of their hop additions. The FWH beer was prepared by adding the hops to the kettle before pump-over. The FWH technique exposed the hop material to warm wort at a pH of 5.35 for approximately 100 minutes prior to boil. Over the course of pump-over, the initial wort temperature ranged from 57.8 to 55.9 C and the concentration changed from 17.6 to 15.5 plato prior to adjustment to the target plato of 12 pre-boil. The control beer was prepared by adding the hops at the start of boil. Chemical characteristics for both worts were approximately the same.



Base Beer Recipe	
Pale malt	98.5%
Acidulated	1.5%
CaCl	50ppm
$CaSO_4$	50ppm
Cascade hops	240 g/hL
Ale yeast	10^6 cells/mL/P°

Figure 1: Base beer recipe and FWH wort temperature and degrees plato during pump-over.

Chemical Evaluation:

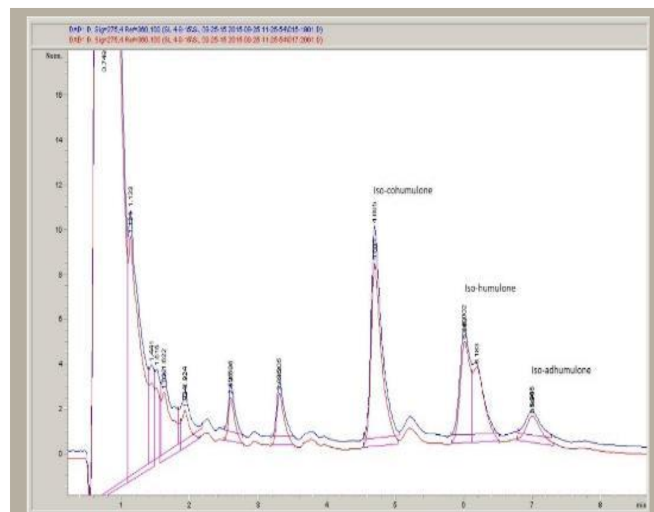
- Beer Analytics – Beer quality parameters such as ABV, AE, and RE were analyzed using an Anton-Parr Alcolyzer.
- Foam Analytics – Beer foam quality was measured using Haffmans Nibem-TPH and Nibem-CLM.
- Iso-alpha acids – IAA were measured using high performance liquid chromatography in accordance with ASBC method Beer 23.
- Bitterness Units – BUs were measured by manual iso-octane extraction in accordance with ASBC method Beer 23.
- Total Polyphenols – TPP was measured in accordance with ASBC method Beer 35.
- Aroma compounds – Qualitative analysis of the aroma fraction was assessed using GC-MS.

Sensory Evaluation: Difference Testing

The two beers were evaluated by a sensory panel consisting of 35 individuals ages 21 to 40. Of the 35 panelists, 26 were male and 9 were female. All panelist were self-identified beer drinkers. The panelists evaluated the two beers using the duo-trio test. Each panelist was given two unknown samples and one reference sample. Of the two unknown samples, one was the reference sample. The panelists were instructed to taste the samples and identify which of the unknown samples matched the reference.

Results: Chemical

As seen in the chromatogram and table below, the two beers differed only slightly in their concentration of bittering compounds. Total iso-alpha acid content for the two beers was the same and the BU values differed slightly. FWH beer had slightly lower BU value coupled with a slightly higher total polyphenol content (TPP), suggesting that FWH technique may influence the extraction of polyphenolic material.



Compound	Control	FWH
Iso-cohumulone	47%	50%
Iso-humulone	43%	41%
Iso-adhumulone	10%	9%
Total Iso-α acids	28.5 mg/L	28.5 mg/L
Bitterness units	37.2	34.2
Total polyphenols	207 mg/L	221 mg/L

Figure 2: To the left, the FWH beer's peak absorbance is shown in blue, and the control beer's peak absorbance is shown in red. To the right, the corresponding concentrations of bittering compounds.

Measurement	Control	FWH
ABV (% W/V)	6.06	6.07
AE (%W/W)	2.16	2.06
OG (%W/W)	13.5	13.4
RE (%W/W)	4.32	4.23
ADF (%W/W)	84.0	84.7

Figure 3: Beer Analysis

Beer analysis revealed little difference between the finished beers. Any differences observed in the two beers (table 3) is slight and well within the tolerance of variation expected between independent brews on OSU's pilot brewing facility.

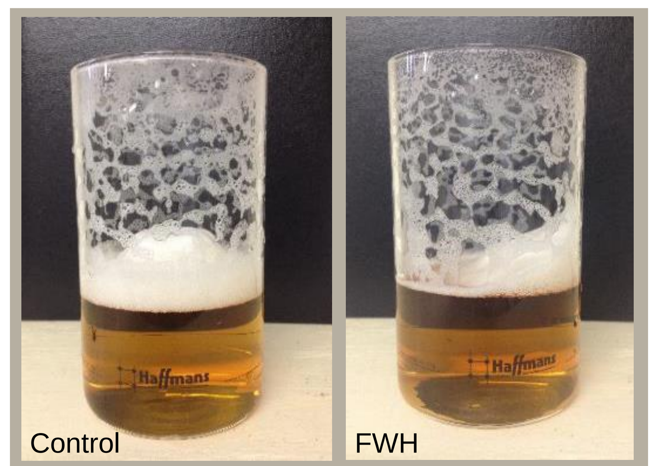


Figure 4: Cling formation patterns

Foam analysis yielded little difference between the beers. The Nibem 30 value was 14 seconds higher for the control beer, and the percent cling value for both beers was within 1%.

Measurement	Control	FWH
Nibem 30 (s)	248	234
Cling (%)	58	57

Figure 5: Foam stability and cling values

Figure 6 shows that the qualitative GC-MS analysis revealed little difference between the two beers. Despite the belief that FWH improves hop aroma, the three predominate peaks observed are fermentation esters and no evidence of hop derived aroma compounds was observed.

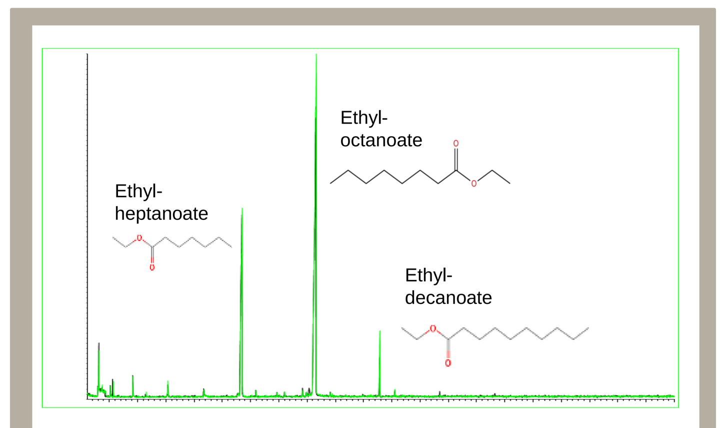


Figure 6: Qualitative GC-MS results of the FWH beer in black and the control beer in green.

Results: Sensory

Of the 35 panelists, 22 could correctly match the unknown sample to the reference sample. These results provide evidence that there is no perceivable sensory difference between the two treatments at a 95% confidence level (one-sided t-test, p-value = 0.067). It is worth mentioning, that for the two beers to be considered significantly different, 23 of the 35 panelists would have to correctly match the reference sample.

Conclusions

Chemical analysis showed minute differences between the two beers with the exception of their total polyphenol content (TPP) and foam stability. The FWH beer was slightly higher in TPP compared to the control beer, suggesting that FWH technique may influence the extraction of polyphenolic material. It is probable that the increased contact time between the hops and wort during FWH would increase the levels of water soluble polyphenols, leading to an increase in TPP. Since polyphenols are known to precipitate wort proteins in the brew kettle, it is probable that the increased TPP seen in the FWH beer is responsible for its reduced foam stability. However, the slight differences in TPP concentrations did not appear to influence the sensory perception of the finished beer. Sensory discrimination testing showed no difference between the reference and FWH beer (significance level 0.05). The lack of difference chemically and sensorially leaves little argument for the use of the FWH technique, and based on the results of this study, the reduced foam stability observed in the FWH beer may prove to be a deterrent to many brewers.

References

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