Scaling Hops

A comparison between homebrew and commercial scale utilization

*Eric Bean and Frank Barickman*
Outline

• Background
• Method
• Differences
• Lab Analysis Results
• Sensory Results
• Conclusions
Background

• Columbus Brewing Company’s “Hop Odyssey Series”
  • Helped learn what effects hops and rate had on beers
  • Learned can only put so much in the kettle and whirlpool
• Brewed several batches commercially and noticed process differences between home brewing and the commercial brewing.
  • 30 BBL vs 10 gallon
  • Hops never came through on homebrew version compared to commercial version.
  • Started experimenting and adapted certain processes.
  • Inspired many conversations and discussions (and beers).

Why is there something different between your batch and mine?
Hop Utilization

- Hop utilization is the percentage of alpha acids that are isomerized and remains in the finished beer.
  - The utilization of the bitter substances rarely exceeds 30% in commercial breweries and is often much lower.
  - O.G., brew house equipment, etc.

- Estimate Bitterness for your beer.
  - Well know for traditional hopping techniques

Tinseth (http://www.realbeer.com/hops/research.html)
Commercial - Utilization

• Calculate IBUS from an in-house formula, its used as a baseline when creating new recipes.
  • Know the number is not actual but know the results (in flavor).
  • Repeatable
• Perception vs. Numbers

“IBUs have become more of a marketing tool when really it’s an analytical tool.” - Eric Bean 2014
Method

• Recipe
  • Columbus Brewing Company’s flagship IPA as base beer
• Brew 3 batches
  • 3 – Production 30BBL batches
  • 3 – 15 gallon Homebrew Versions
    • Change hopping schedule in each homebrew version
• Pitch same yeast at same pitching rates
• Ferment similar times and temperature
• Lab Analysis of all 6 batches
• Sensory Analysis of all 6 batches with taste panel
Columbus IPA (Base Recipe)

• 30 BBL (about 230- 5 gal HB Batches)
• OG 14.5P (1.059)
• FG 2.8P (1.011)
• SRM – 8
• IBUs – 55 (Estimate- More to come)
• 90 minute boil
• ABV – 6.3%
Columbus IPA- Hombrew (5 Gal)

- 9.5 Lbs Superior Pilsner
- 2.0 Lbs Vienna
- 0.5 Lbs C45

- 90 Min: Columbus – 0.5 Oz- 30.3 IBUs
- 45 Min: Centennial – 0.18 Oz- 6.2 IBUs
- 15 Min: Citra – 0.41 Oz- 11.2 IBUs
- Whirlpool: Simcoe – 0.44 Oz- 4.6 IBUs
- Whirlpool: Amarillo – 0.44 Oz – 3.25 IBUs
- Dry Hop - Simcoe – 4.8 Oz – 0 IBUs
- Dry Hop - Amarillo – 4.8 Oz – 0 IBUs
# Hop IBU Estimation – 30 BBL Commercial

<table>
<thead>
<tr>
<th>Hops</th>
<th>Add Time</th>
<th>CBC Est</th>
<th>Tinseth</th>
<th>Rager</th>
<th>BeerSmith</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columbus</td>
<td>90</td>
<td>34</td>
<td>27.7</td>
<td>33.6</td>
<td>24.7</td>
</tr>
<tr>
<td>Centennial Select</td>
<td>45</td>
<td>5</td>
<td>5.9</td>
<td>6.8</td>
<td>5.3</td>
</tr>
<tr>
<td>Citra</td>
<td>15</td>
<td>8</td>
<td>10.7</td>
<td>6.8</td>
<td>9.6</td>
</tr>
<tr>
<td>Simcooe</td>
<td>Whirlpool</td>
<td>4.6</td>
<td>0</td>
<td>0</td>
<td>4.6</td>
</tr>
<tr>
<td>Amarillo</td>
<td>Whirlpool</td>
<td>3.25</td>
<td>0</td>
<td>0</td>
<td>6.8</td>
</tr>
<tr>
<td>Simcoee</td>
<td>Dry</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Amarillo</td>
<td>Dry</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>54.85</td>
<td>44.3</td>
<td>47.2</td>
<td>51</td>
<td></td>
</tr>
</tbody>
</table>
Homebrew Batches

- Pull 19 gallons wort from Kettle @ Boil
- Boil 19 gallons for 15 gallons @ Knockout

<table>
<thead>
<tr>
<th>Hop</th>
<th>#1 Hop Addition (Minutes)</th>
<th>#2 Hop Addition (Minutes)</th>
<th>#3 Hop Addition (Minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columbus</td>
<td>90</td>
<td>90</td>
<td>0</td>
</tr>
<tr>
<td>Centennial Select</td>
<td>45</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Citra</td>
<td>15</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Simcoe</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Amarillo</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Simcoe</td>
<td>Dry</td>
<td>Dry</td>
<td>Dry</td>
</tr>
<tr>
<td>Amarillo</td>
<td>Dry</td>
<td>Dry</td>
<td>Dry</td>
</tr>
</tbody>
</table>
## Hop Additions By IBU (15 Gallon)

<table>
<thead>
<tr>
<th>Hop Type</th>
<th>IBU</th>
<th>Time</th>
<th>Oz.</th>
<th>IBUs</th>
<th>Time</th>
<th>Oz.</th>
<th>IBUs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Batch #1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Columbus</td>
<td>34</td>
<td>90</td>
<td>1.38</td>
<td>32</td>
<td>90</td>
<td>1.38</td>
<td>32</td>
</tr>
<tr>
<td>Centennial Select</td>
<td>5</td>
<td>45</td>
<td>0.52</td>
<td>6.8</td>
<td>0</td>
<td>1.25</td>
<td>6.5</td>
</tr>
<tr>
<td>Citra</td>
<td>8</td>
<td>15</td>
<td>0.75</td>
<td>7.3</td>
<td>0</td>
<td>1</td>
<td>7.6</td>
</tr>
<tr>
<td>Simcoe</td>
<td>4.6</td>
<td>0</td>
<td>1.26</td>
<td>4.6</td>
<td>0</td>
<td>1.26</td>
<td>4.6</td>
</tr>
<tr>
<td>Amarillo</td>
<td>3.25</td>
<td>0</td>
<td>1.26</td>
<td>3.25</td>
<td>0</td>
<td>1.26</td>
<td>3.25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>54.85</td>
<td>5.2</td>
<td>54</td>
<td>6.2</td>
<td>54</td>
<td>6.2</td>
<td>54</td>
</tr>
<tr>
<td><strong>Batch #2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Columbus</td>
<td>32</td>
<td>90</td>
<td>1.38</td>
<td>32</td>
<td>90</td>
<td>1.38</td>
<td>32</td>
</tr>
<tr>
<td>Centennial Select</td>
<td>6.8</td>
<td>0</td>
<td>1.25</td>
<td>6.5</td>
<td>0</td>
<td>1.25</td>
<td>6.5</td>
</tr>
<tr>
<td>Citra</td>
<td>7.3</td>
<td>0</td>
<td>1</td>
<td>7.6</td>
<td>0</td>
<td>1</td>
<td>7.6</td>
</tr>
<tr>
<td>Simcoe</td>
<td>4.6</td>
<td>0</td>
<td>1.26</td>
<td>4.6</td>
<td>0</td>
<td>1.26</td>
<td>4.6</td>
</tr>
<tr>
<td>Amarillo</td>
<td>3.25</td>
<td>0</td>
<td>1.26</td>
<td>3.25</td>
<td>0</td>
<td>1.26</td>
<td>3.25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>56</td>
<td>8.8</td>
<td>56</td>
<td>8.8</td>
<td>56</td>
<td>8.8</td>
<td>56</td>
</tr>
<tr>
<td><strong>Batch #3</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Columbus</td>
<td>4</td>
<td>90</td>
<td>1.38</td>
<td>32</td>
<td>90</td>
<td>1.38</td>
<td>32</td>
</tr>
<tr>
<td>Centennial Select</td>
<td>6.5</td>
<td>0</td>
<td>1.25</td>
<td>6.5</td>
<td>0</td>
<td>1.25</td>
<td>6.5</td>
</tr>
<tr>
<td>Citra</td>
<td>7.6</td>
<td>0</td>
<td>1</td>
<td>7.6</td>
<td>0</td>
<td>1</td>
<td>7.6</td>
</tr>
<tr>
<td>Simcoe</td>
<td>4.6</td>
<td>0</td>
<td>1.26</td>
<td>4.6</td>
<td>0</td>
<td>1.26</td>
<td>4.6</td>
</tr>
<tr>
<td>Amarillo</td>
<td>3.25</td>
<td>0</td>
<td>1.26</td>
<td>3.25</td>
<td>0</td>
<td>1.26</td>
<td>3.25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>56</td>
<td>8.8</td>
<td>56</td>
<td>8.8</td>
<td>56</td>
<td>8.8</td>
<td>56</td>
</tr>
</tbody>
</table>
Differences

• Kettle Geometry (in a perfect world)
  • Commercial – Sheer Volume – Lots of oils!
  • More contact heating surface area
  • Also better thermal mass

• Boil-off Volume
  • 30BBL
    • Steam Boiler – Heat applied from bottom and sides
    • Boil loss – 31/33BBL gallons (5%)
    • Older brewhouse – Battle between yield and quality
  • 15 gal
    • Direct – Heat applied only at bottom
    • Boil loss – 4.25 Gallons (15%)
    • More carmelization of the wort and darker SRM into the fermenter
Differences
Differences

• Whirlpool Vs Steep
  • 30 BBL
    • 30 minutes to transfer 30BBL wort to Whirlpool (less trub in whirlpool)
    • Hops added @ 10 minute whirlpool and start transferring to ferment from top
    • 60 minutes to transfer from Whirlpool thru heat exchanger to Fermenter
      • Hops still in contact with some wort during this time
      • Temperature remains relatively constant during this time 212F to 200F at Whirlpool
  • 15 Gal
    • 0 time to transfer for 15 gal version (More trub)
    • Stir Like Hell!!!!! Then rest...
    • 15 minutes to transfer from Whirlpool thru heat exchanger to Fermenter
    • Temperature drops from 212F to 187F during 30 min steep
Lab Analysis

Thanks Rich Michaels of F.X. Matt Brewing for providing lab analysis for this talk
### BU Results

<table>
<thead>
<tr>
<th>Batch</th>
<th>IBU</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>65.0</td>
</tr>
<tr>
<td>C2</td>
<td>62.4</td>
</tr>
<tr>
<td>C3</td>
<td>64.0</td>
</tr>
<tr>
<td>HB1</td>
<td>64.9</td>
</tr>
<tr>
<td>HB2</td>
<td>---</td>
</tr>
<tr>
<td>HB3</td>
<td>61.5</td>
</tr>
</tbody>
</table>
Sensory Analysis
Sensory Overall

- Bitterness level was perceived similar in all beers
  - Commercial beers were perceived to have a cleaner fermentation character
- Hop aromatics and flavors in HB3 were most similar to the commercial versions
  - HB3 was much fresher – 2 mos.
- HB1 had similar bitterness, but perceived with less hop character in aroma and flavor.
- HB2 was more similar to HB3, but not as intense.
Conclusions

• Bitterness scales in a more predictive manner than does hop flavor or aroma.
  • Formulas under predict BU’s but are fairly consistent.
  • Can get significant bitterness from late addition hops.

• Preliminary results suggest that greater hop mass contributes more hop aromas and flavors.
  • But excessive amounts are not needed

• The best method to understand hop utilization is to brew using your system and be consistent with how you estimate bitterness.
  • Adjust based on your results
  • Be Consistent
Thanks for coming!

Questions?