In Hop Pursuit

The OSU-Indie Hops Aroma Breeding Program

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Indie Hops, LLC
 Indie Hops – We Sell Flavor

- INBEV/Bud pulls plug on public breeding
- $1 Million (now $1.3M)
- Increase Oregon hop acreage
- Increase Genetic Diversity
- Increase Yield/Disease Resistance
- First Oregon Merchant with “cool” Pellet Mill
- Breed new aromas & flavors
The Nectar

**HOP ANATOMY**

- **Lupulin Glands**: Most of the power from the hops is packed inside these volatile lupulin glands. The glands ball together into sticky yellow clusters which contain resins, acids, and essential oils. The resins contain the bittering compounds and the oils contain the aroma substances. The alpha acids (humulones) and beta acids (lupulones) are what give beer that bitter taste.

- **Bracteoles**: Key components responsible for hop flavor, hop aroma and hop bitterness in beer are the essential oils and resins found in and on the hop leaves themselves. Even the leaves of mature cones ooze a smattering of lupulin. The bracteoles and leaves of the cone also contain tannins which are also good for the plant. They can help ward off bacteria and fungi, and the polyphenols they produce help protect plants and beverages from the ravages of oxidation. If you sip a beer and your mouth puckers, it’s probably because your beer is loaded with tannins, which interact with your salivary glands.

- **Strig**: Most of the tannins in a hop cone are actually found in the strig and stem, as opposed to a very low percentage in the hop leaves. These tannins pump out the medicinal or bioactive properties of hops, also known as polyphenols. This is what vitamins, energy drinks and all manner of magical potions, powders and elixirs are made of. These would include those natural little life-sustaining gems like flavonoids, catechins, quercetin and xanthohumol. In the human body, they’re supposed to roam through the immune system scavenging free radicals which can trigger fatigue, inflammation and, much worse, cancer. Hops contain one of the highest levels of polyphenols in plants (around 4-6% by weight). The polyphenols also contribute to the harshness or smoothness of the bitterness.
OSU-Indie Hops Breeding Program

- Complex Chemistry, Many unknowns
- Essential oil content and quality
  - Over 400 known oil components
  - Another 400 unnamed, tracking 40
- What oils are desirable? Can we target?
- Is more total oil better?
- Hop Maturity – Optimum harvest time?
- Dry Hop – when and how long?
- How is Flavor influenced by malt, yeast, adjuncts, hop combos, liberated glycosides, staging, amounts, etc?
1. Controlled breeding. E.g., Tiny brush method.
2. Open Pollination. Multiple Daddies?
Patience You Must Have…

- Year 1 - Crosses, greenhouse selections (10-14k seeds yr)
- Year 2 - Establish field nursery (200)
- Year 3 - Field notes, "baby year"
- Years 4-6 - Yield, chemical evaluations, sensory, hop teas, pilot brews (maybe 5 gamers?)
- Years 7+ - Advanced testing on farms, expand acreage, pilot brews
- It usually takes 9 or more years to develop a new hop cultivar…young padawan
Breeding Program Traits
Agronomic Focus

- Yield (> 8 bales/ac or 1600 lbs/ac)
- Disease resistance
  - Downy, powdery mildews
  - Public varieties getting tired?
- Pest resistance
  - Two-spotted spider mite, hop aphid
- Time to maturity
  - Avoid fall rains in Willamette Valley
- Suitable to Oregon Terroir
2009: OSU gardener offers open-pollinated seeds from backyard.

- Perle is the Mother
- Father is unknown (rogue Oregon hop stud?)
- N. American Wild Type?
- Race to fertilize fierce around Corvallis
The Chosen One – x331

• 2012: OSU Ferm Science brewbots spot X331 at OSU research farm. “The One.”

• 2012 (Fall): IH sensory analysis. Near whiplash on dry rub. Harkens back to days of youth roaming valley intoxicated by “Indian Tobacco” and low hanging free fruit.

• Fast tracked to Farm Trials.
X331: A Shooting Star?

- **2013:** After choosing best X-331 plant, propagate clones and plant at Goschie and Coleman farms. Pilot brewing at Worthy and other breweries. Wins “best of show” at Basecamp Brewing Protohop Brewfest in Portland.

- **2014:** First “baby” harvest from farm trials in 2014. Pilot brewing activity spurs excitement.
X-331: Ramping Up

• 2015: Too good to wait. Indie Hops decides to propagate and plant commercial trial acreage. About 9 acres.

X-331: A Go-To, Stand Alone?

- Worthy Lookout freshhop beer.
  
  “Passion Fruit meets Pot.”
  
  “Showhorse meets workhorse.”

  Multi-layered. Passion fruit, grapefruit, mango with a whiff of weed.

  All-purpose.
A Peak at the Chemistry

12-16% Alpha (tad higher than Cascade and Perle)

Total Essential Oils

• 3 mls/100gms
  (higher Centennial / 2.7 mls/100 gms)

• Alpha terpineol – tropical fruit
  • 3-10x more than Cascade & Perle

• Citronellal (fruity)
  • 3x > Cascade
  • 5x > Perle
X-331: The Bones of a Champ?

- Citronellol (citrusy, fruity)
  - 4x > Cascade
  - 3x > Perle

- Linalool (floral & Orange)
  - 2x More Cascade & Perle

- Trans caryophylene (woody)
  - 5x greater than Cascade
  - 3x greater Perle

- Alpha humulene (Piney)
  - 2x greater Cascade & Perle
Proud Hop Daddies

3 years ahead of schedule
A Hop Star is Born?

Gold Medal Oregon Beer Awards 2017 – Hoppy Session IPA.
In Summary, We are Oregon Proud of this:

- We use traditional breeding techniques, primarily controlled crosses between male and female plants. No GMO or Gene Splicing techniques.

- 10,000-14,000 seeds collected each season. Narrows to just a few hundred by the following spring due to the disease gauntlet in greenhouses over the first winter.

- Roughly 200 genotypes harvested each year in the experimental field, based on vigor, DR, etc.

- These 200 evaluated for brewing characteristics, first through dry rub, then dry hopping in a “neutral” base beer, then via small scale (1/3 barrel) pilot brews.

- Perhaps 5 of the 200 remain and are planted out in farm plots of 30 hills/plants.

- Larger scale pilot brewing takes place using the farm plot hops. Maybe, if we’re lucky…just maybe we’ll have one hop from each farm plot that ends up proving worthy of commercial launch.
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<th>2010</th>
<th>2016</th>
<th>Percent Change</th>
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<tbody>
<tr>
<td>Total Oregon Hop Yield in lbs</td>
<td>8,278,000</td>
<td>11,8000,000</td>
<td>42.55%</td>
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<tr>
<td>Oregon Hop Acreage in Production</td>
<td>4,622</td>
<td>7,669</td>
<td>65.92%</td>
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*10.6% increase in total yield from 2015-2016
*16% increase in Total Oregon hop acreage
• Evaluation of more than 1500 hop genotypes over multiple years
• Crosses involving 38 females and 20 males (+5 OP)
• Establishment of 14 advanced selections among six replicated nurseries on two commercial hop farms
• Establishment of commercial experimental blocks on two farms for one advanced selection
• Selection of a promising ornamental genotype that is being evaluated by industry
• Mentored 5 interns
• Mentored/Mentoring 2 graduate students
• Provided experience for at least 10 undergraduate research assistants
• Published 18 peer-reviewed and miscellaneous publications
Future Challenges

Climate Change?
Draught Tolerant hops?
Concentration Proprietary Hops
25% 2017 Crop Simcoe, Summit, Mosaic, Simcoe
Good for farmers? Customers? Public hops?
IH 600 acres, 70 new for Strata
Add another 5000 acres 2017