Dry Hop Creep

by Brynn Keenan, Grist Analytics

If done incorrectly dry hopping results in long cellar times, diacetyl issues, and over pressurized cans - collectively, these phenomena are known as hop creep. Diving into the process data tracked by Grist, we've seen that some breweries are achieving IPA cellar times of 150hrs with no diacetyl/over attenuation issues, while others are taking 500hrs. We'll discuss the science behind hop creep, and how to manage it effectively.

The Science

Hops contain enzymes that break down unfermentable dextrins into fermentable sugars. When this happens in the presence of even a small concentration of yeast, fermentation will occur. While the extraction and enzymatic activity are greater with warm dry hopping, it can still occur with cold hop additions. The concentration of these enzymes changes with hop strain, lot, and processing method.

Hop Enzymes

- Alpha amylase
- Beta amylase
- Limit dextrinase
- Amyloglucosidase

The first issue that this presents is over attenuation. Yeast can now process more sugar into alcohol and CO2. If this happens in the cellar, the beer will be out of specification for alcohol. If it happens in can, it will be out of specification for alcohol and over carbonated.

The second issue is diacetyl production. When yeast consumes sugar in the presence of oxygen, a larger amount of diacetyl is produced. Unfortunately, oxygen is often introduced while dry hopping. If this is happening at the tail end of fermentation when yeast is less active, diacetyl may be an issue in the final beer.

We'll move forward with how to accommodate and/or avoid these issues. If you'd like a deeper dive into the science check out these additional resources.

Brewer's Association Technical Brief - Hop Creep

Podcast - Dry Hop Creep

Podcast - Dry Hopping & Diacetyl

Dry Hopping and VDKs - Shellhammer Lab

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Defining The Beer

It is helpful to know the sensory, yeast, and production goals for the dry hopped beer as they may require prioritizing. Consider these items:

- Dry hop timing (see resources below for more information)
  - Analytical differences in dry hop timing
  - Lallemand guide to biotransformation
- Off flavors
  - What is the tolerance for diacetyl?
  - Aroxa guide to diacetyl
  - *Note that diacetyl threshold in IPAs is not well researched
- Attenuation/Alcohol
  - Are you anticipating hop creep in fermenter or packaged product?
  - Hop enzymes persist in package - page 89
- Fermentation time
  - How long can this beer take in the cellar?
- Yeast availability
  - Will you need to crop from this beer?
  - Detrimental effect of heavy dry hopping on yeast

Achieving Defined Beer

Now that both the beer and production needs have been defined, we can develop a cellar plan to achieve them.

1. Determine Hop Creep Potential

It is safest to accommodate hop creep during primary fermentation. Knowing the extent to which this will happen for each beer will allow accurate scheduling, dry hopping, and final gravity estimation. Here are two easy tools for this.

Estimated Attenuation

Anticipate the extent of DH creep by performing two estimated attenuations. One will include wort + yeast, while the other will include wort + yeast + hops. The difference will help you estimate extent of hop creep. Follow the ASBC method or contact Grist for the SOP.

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Fermentation Modeling

Model your average IPA fermentations per hop lot to anticipate the extent and duration of dry hop creep. This can be done using a multivariate regression (contact us for instructions), or Grist can crunch the numbers for you.

2. Accommodate Yeast Needs

Understanding what the yeast needs will allow you to make choices that balance hop aroma, cropping, and production timing.

- The healthier the yeast, the less likely it is that you will have issues with diacetyl and trickling fermentations (Maintaining yeast health)
- The earlier hops are added to fermentation, the less likely it is that you will have issues with diacetyl and trickling fermentations (White Labs Research)
- To minimize fermentation time and maximize yeast health, harvest yeast warm after flocculation (Loveridge et al. 1999).
- Yeast strains differ in their ability to consume sugar at the tail end of fermentation, and produce/reduce diacetyl (research on this is underdeveloped - Diacetyl by strain). Talk with a yeast supplier about your specific needs.
- The bottom of a fermenter is not a healthy place to store yeast while waiting on hop creep. Dumping old yeast, harvesting/pitching in a timely manner, and storing yeast cold are imperative for current/future fermentation performance.

3. Dry Hop Timing - Critical

Dry hopping early in fermentation is the best way to mitigate diacetyl issues and prolonged fermentations. There are disadvantages to this including CO2 scrubbing of aroma, inability to harvest yeast, and a modified aroma profile from biotransformation. With that in mind, consider these guidelines to choose the right time.

1. If yeast is not needed, dry hop anytime before 1-2P from terminal depending on desired ester profile (Flavor Impacts of Dry Hop timing). Dump yeast as it accumulates in the fermentor cone to avoid autolysis off flavors.
2. Do not dry hop a beer less than 1-2P from terminal without additional process aids and ample cellar availability.
3. If yeast must be harvested from the beer, harvest after flocculation and before dry hopping. It is best to avoid harvesting yeast after dry hopping.
4. Dry hopping cold is an option, but must be done with caution. If yeast is present even at a small concentration in package, secondary fermentation may still be an issue.

5.

Process Aids/Investments

In addition to the guidelines above, these process aids may help achieve your fermentation and sensory goals.

Reduce Oxygen

This will not prevent hop creep, but will help with diacetyl production. Yeast produces more diacetyl when oxygen is present. Reduce the amount of oxygen introduced during dry hopping, and you will reduce diacetyl production.

Process Aids

Alphalase or *ALDC* can be added to prevent diacetyl production. It will not help after diacetyl has been produced. Talk to your supplier about timing/dose. This will not prevent hop creep, only diacetyl formation.

Amyloglucosidase can be added to break down complex sugars in solution. This will pre-empt the action of hop enzymes and will help with both hop creep and diacetyl formation.

Pasteurization

Pasteurization will denature hop enzymes, stabilizing the beer. To avoid diacetyl production, a quick turnaround time is needed after warm dry hopping. Dry hopping cold provides more timing flexibility, since hop enzymes will be less active at a lower temperature.

Temperature

Dry hopping cold will reduce hop enzyme activity while in tank. This is not recommended as a solution for hop creep unless yeast is being removed with an appropriately sized filter before packaging. If yeast is not removed, secondary fermentation in package may still occur.

Allowing the beer to free rise to the top of the temperature band after dry hopping will help promote yeast activity including fermentation and diacetyl reduction.

Damage Control

With the resources above you should be able to reliably produce dry hopped beers. If something does go wrong, there are a few options for salvaging the brew.

Waiting Game. If there is yeast in suspension it may eventually finish trickling and reducing diacetyl. Dumping the bottom portion of yeast in the cone, and rousing the tank with CO2 may expedite this proccess.

Push Wort. Try pushing in a small amount of fresh wort in conjunction with Alphalase/ALDC. This will induce action and prevent further diacetyl formation.

Push Yeast. Add active yeast from the tail end of another fermentation to expedite hop creep and diacetyl reduction.

Conclusion

A balance must be reached between production timing, yeast needs, and dry hop timing. While this can be time consuming and frustrating, is is absolutely possible to do reliably. Feel free to reach out for additional resources, questions, or direction.

Start A Brewery Note: This article is also available here in the Grist Analytics blog, and additional blog posts will be shared in the Start A Brewery Library on an ongoing basis courtesy of the author.

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Brynn is a biochemist by training and fermentation scientist by trade. Her experience in brewing QC includes building micro, sensory, and analytical programs for Left Hand Brewing and Inland Island Yeast Laboratories. Brynn started Grist Analytics to bring big brewery QC tools to craft by making data entry, visualization, and analysis easy. She now helps breweries across the world turn production data into actionable information. Brynn is passionate about good beer, rock climbing, and building community.