
# Advanced Mashing

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Minneapolis, MN

# Presenters


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# Advanced Mashing

**Goals:**

- Produce high quality wort
  - Full Starch Gelatinization
  - An Efficient Mash
  - A Quick Mash
  - Effective Lauter and Collection
- Expand Ingredients
  - Extend Flavor Profiles and Complexities
  - Adapt for Ingredient Availability

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# Advanced Mashing

- Malting & Modern Malts
- Measuring vs Timing
- Enzymes
- A Mash Program
- Control and Test Brews
- Process & Measurements
- 2 Beers for Drinking!

# Modern Malted Barley

## Qualities

- Higher Yield
- Diastatic Power
- Correct Protein Levels
- Consistent Color
- Consistent Performance

## Why

- Cultivars
- Industrialized Malting
  - Applied Science
  - Indirect Kilns
  - Only the best barley

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# A warmer globe, A changing Malt

Starch structure is .... modulated when plants encounter harsh environment during the growing seasons. If the growing environment alters the compositional parameters of starch, the downstream processing of these starches for specific application may need to be adjusted to maintain product quality.

For brewers, it is important to know the gelatinization temperature of malt in order to achieve a complete gelatinization of starch.

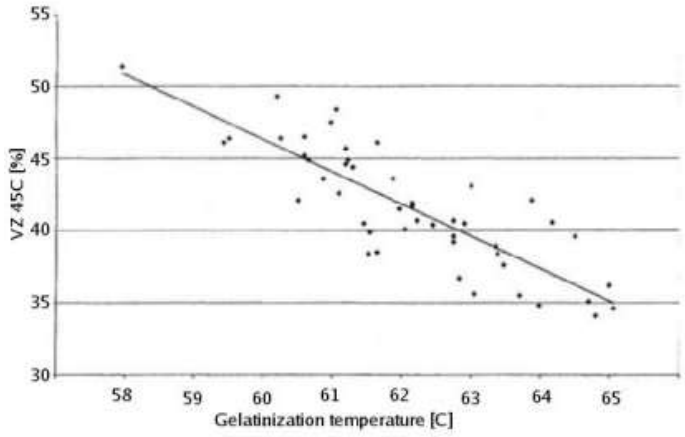
High gelatinization temperatures can lead to incomplete saccharification rates which cause problems during the brewing process and decrease the yield of raw materials as well as the quality of beer.

Depending on the climatic conditions, gelatinization temperature varies every year.



Beckles and Thitisaksakul Department of Plant Sciences, University of California, Davis, CA, USA
Chris Colby, Barley Starch for Brewers

# Important numbers for Mashing




The gelatinization temperatures for barley malt have increased to as high as 65C/149F.

**Beta-amylase:**

Temperature range 140 and 149 °F (60–65 °C)

Optimal pH range is 5.4–5.5.

**Alpha-amylase:**

Temperature range 149 and 167 °F (65–75 °C)

Optimal pH range is 5.6–5.8.

# Application of Brewer's Enzymes

- **Amyloglucosidase**
  - Aid in conversion
  - Mash and/or fermentation applicable
  - Increases fermentability of wort
- **Fungal α-amylase**
  - Ensures complete conversion
  - Mash and/or fermentation applicable
  - Reduce starch/dextrin turbidity in finished beer
- **Endo-amylase**
  - Conversion of non-malted cereals
  - Aids starch liquefaction
  - Heat stable variants
- **Beta-glucanase**
  - Ensures good flow and collection (Lauter)
  - Improve extract
  - Haze reduction

# Enzyme Overview

**Natural Enzymes in Malt**

| | |
|---|---|
| ○ Phytase | 86°-126°F |
| ○ Beta-Glucanase | 95°-113°F |
| ○ Proteinase | 111°-131°F |
| ○ Beta-Amylase | 131°-150°F |
| ○ Alpha-Amylase | 149°-162°F |
| ○ Denaturing of Enzymes | 165°F+ |

**Commercial Enzymes for the Brewer**

| | |
|---|---|
| ○ Amyloglucosidase | 131°-150°F |
| ○ Fungal α-amylase | 125°-144°F |
| ○ Endo-amylase | 130°-150°F |
| ○ Thermo-stable Endo-amylase | 160°-190°F |
| ○ Beta-glucanase | 120°-140°F |

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# Commercial Enzyme Sources

- Fungal Sources of Enzymes
  - Bacillus subtilis
  - Aspergillus
  - Trichoderma
  - Penicillium

**Why Additional Enzymes**

- Benefits of using non-malt Enzymes
  - Heat stable up to nearly 190℉
  - Complete enzymatic activity at lower temps down to 120℉
  - Expanded enzyme mix to break down complex polysaccharides and proteins

# The Mash Program

Dough In with strike to 131

- Glucanase rest to increase liquefaction and lauter.

Raise temp to 149

- Starches gelatinize, beta amylase in high gear
  - Continue until gravity hits 80-90% of the first wort target

Raise temp to 158

- Alpha amylase in high gear, glycoproteides are extracted
  - Continue until gravity hits 90-100% of the first wort target

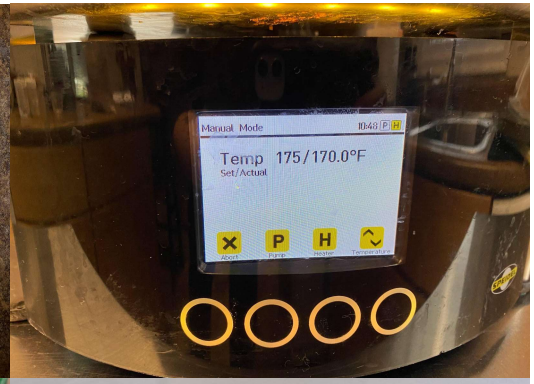
Raise temp to 168 for mash out, and collect

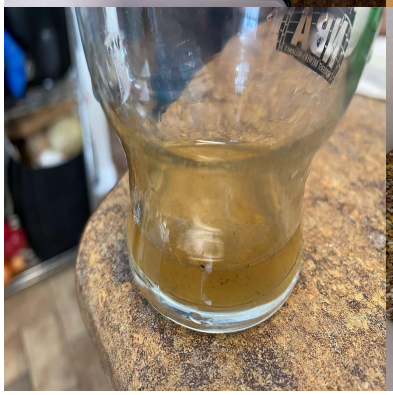


# Measurements

**Every 10 Minutes:**

- Specific Gravity Measurements
- PH
- Iodine testing

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## Control Batch


# American Cereal Lager

## Recipe

- 30% North Star Pils
- 23.3% Raw Corn
- 23.3% Raw Wheat
- 23.3% Flaked Barley

## Process

- Dough in @ 130°F
- Protein Rest @ 120°F for 15 mins
- Cereal Mash Corn @ 210°F for 1 mins
- Combine Corn mash with main mash
- Rest at 151°F
- Ramp to 162°F
- Ramp to 170°F for 5 mins
    - Measurements:
        - starch conversion took 2 hrs
        - gravity rose from 1.010-1.052
- Lauter

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# Control Batch Measurements

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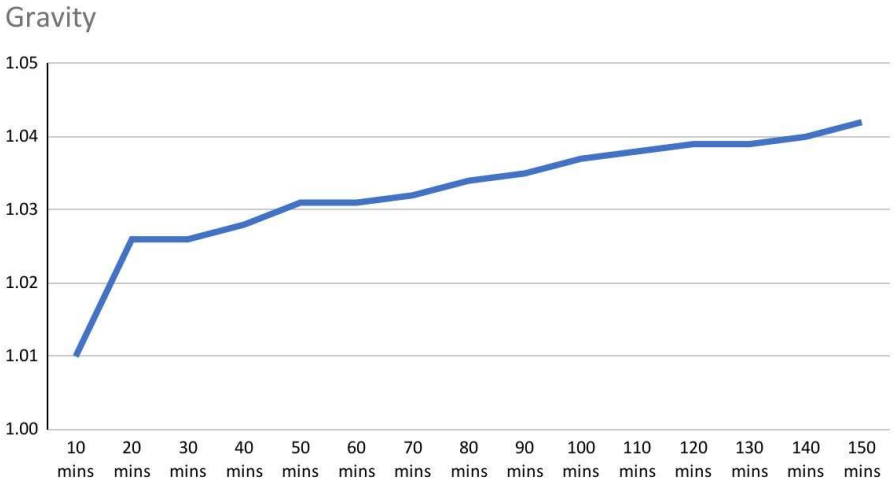


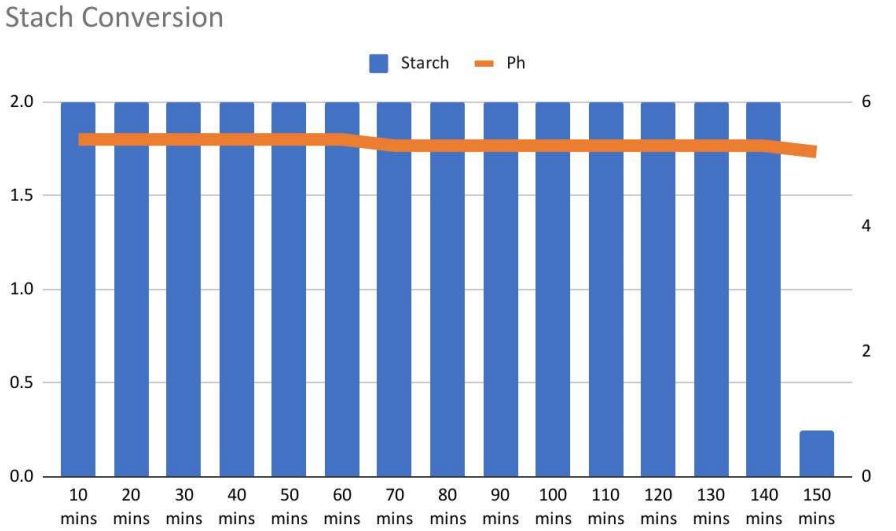

# American Cereal Lager

## Recipe

- 30% North Star Pils
- 23.3% Raw Corn
- 23.3% Raw Wheat
- 23.3% Raw Rye Berries

## Process

- Dough in Corn, Wheat and Rye @ 180°F
- Add Thermo-stable Endo-amylase
- Rest @ 175°F for 10 mins to ensure hydrolyzation of starch
- Add cold water to reduce temp to 155°F
- Add Pils malt, Fungal α-amylase and Beta-glucanase
- Rest @ 148°F
- Ramp to 162°F
- Ramp to 170°F for 5 mins
    - Measurements:
        - starch conversion after 1 hr
        - gravity rose from 1.022 - 1.050
- Lauter

## Enzyme Testing Batch

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# Test Batch Compared to Control

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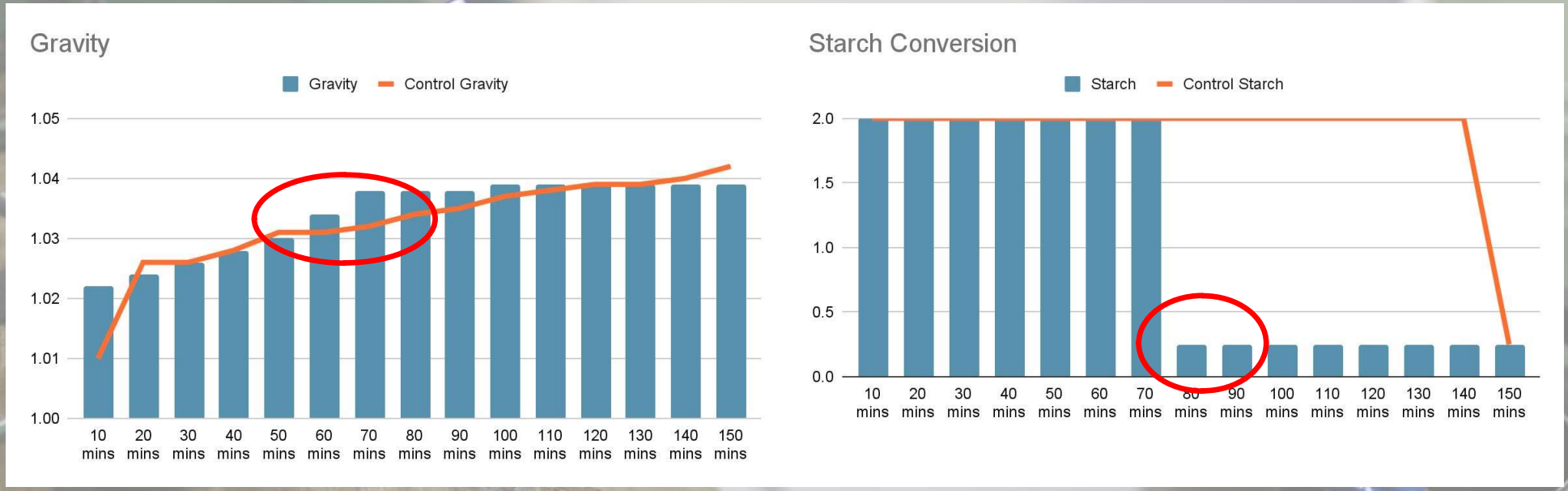

# RyeBerry Hill Pilz

## Recipe

- 50% Weyermann Barke Pils
- 50% Rye Berries
- 0% rice hulls

## Process

- Dough in at 120°F for 20 mins with Pilsner and Rye
    - Add Glucoamylase
- Rest at 145°F for 40 mins while recirculating
    - Add Alpha-Amylase
- Ramp to 150°F for 40 mins, 155°F for 15 mins, 160°F for 15 mins, 165°F for 15 mins
    - Measurements:
        - starch conversion in 30 mins
        - gravity rose from 1.002 - 1.032
- Lauter


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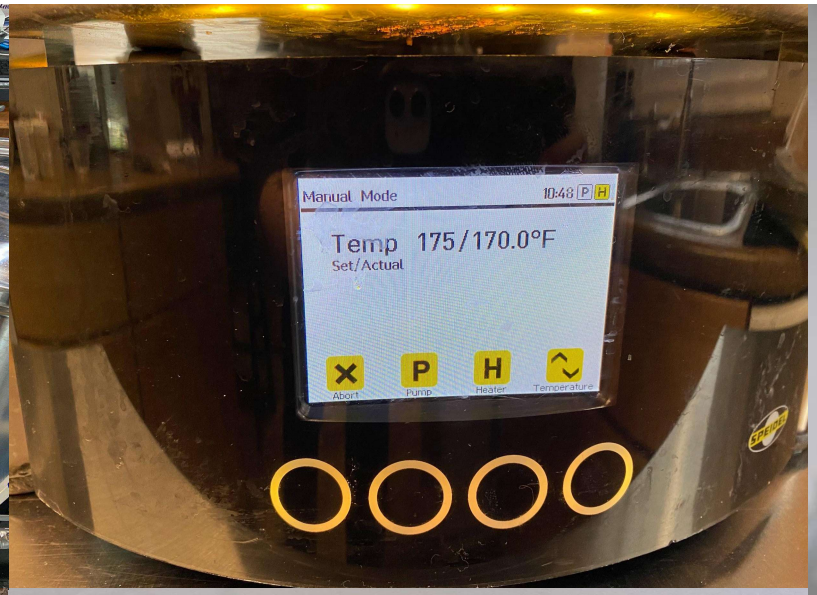
# Results & Advantages

- Shorter Mash
  - Fast conversion with wider range of ingredients
- Higher Efficiency
- Higher % of Adjunct Grains
  - Raw corn, raw rye berries
  - No cereal mash
  - No step mashing
- Wort Fermentability
  - Consistent attenuation
- Stability
- Product Availability
  - Using unmalted grains
  - Using high-protein fermentables
- Availability of Brewer's Enzymes
  - Northern Brewer/Morebeer/Other

# Additional Notes

- Conversion - enzymes are sensitive to their temperature ranges, and these can be outside of the traditional mash temperature ranges
  - we found that the gravity was impacted the greatest during conversion in the middle of the enzymes' recommended range
  - if using enzymes to speed up the brew day, adjust your mash profile to get into the proper temp ranges for the enzyme used
- Starch - starch conversion can happen quickly with the use of certain enzymes, helping with conversion and viscosity
  - when using multiple enzymes, like a traditional mash, note temp ramps as there can be denaturing
- Protein - one of the main properties to pay attention to and select enzymes accordingly (the unmalted rye berries have A LOT of protein!)
  - this is when flow enzymes pair well with amylase enzymes
- Unmalted Grains - the experimental batches focused on using unmalted cereals, and the flavor profiles provided by them.

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# Q & A


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# THANK YOU!

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# Resources

https://bsgcraftbrewing.com/enzymes/
https://www.novozymes.com/en/solutions/brewing