Crisp Malt Webinar Series - Mashing

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Scope

- Definition
- Practical overview
- Mashing processes
- Malt starches
- Converting malt starches to sugar
- Practical factors in the brewhouse to create nutritious wort
- Wort composition

Mashing

Definition

- Mashing is the term given to the start of the brewing process, where crushed grains are mixed with water to form a porridge-like mixture called the "mash." It is in the mash that malt and other cereal starches are transformed into sugars and proteins and other materials are made soluble, creating the sweet fermentable liquid called the wort.

- Milled malt forms the grain mixture called "grist." The grist is mixed with carefully controlled amounts of warm or hot water to form the mash. There are three basic types of mashing process: infusion mashing, decoction mashing, and temperature-controlled infusion mashing. Different mashing processes are used in different parts of the world depending on local tradition, the quality of malt available, the equipment used, and the beer styles brewed. In this presentation we will concentrate on infusion mashing which uses well modified UK malt

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Mashing

Practical Overview

- Essentially a continuation of the malting process
- Crushed malt is hydrated to form a mash at temperatures that encourage starch degrading enzyme activity
- The mash tun should be preheated with hot liquor – discard this before mashing in
- Add foundation liquor to cover the plates – this will protect the mash and avoid cloudy worts – deduct the volume from the total mash liquor required
- Mashes shouldn't be excessively mixed – fine particles will be released and β-glucans can be sheared and extracted
- Use of torrefied cereals directly in the mash can add flavour and dilute nitrogen
- Mash for 45 to 90 minutes and confirm full conversion with an iodine test

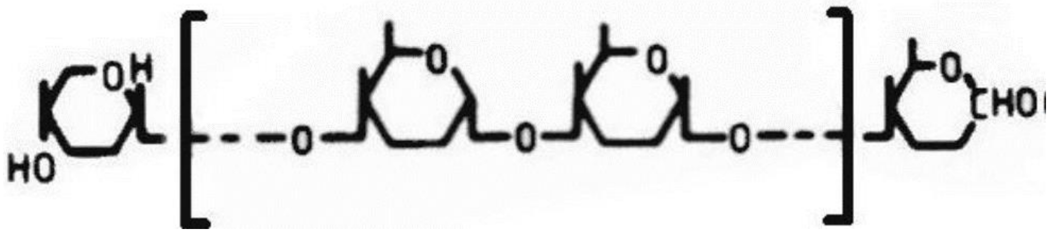
Mashing

Main processes

- Soluble sugars and proteins are leached from the grist particles
- Enzymatic degradation of some of the insoluble grist substances
- Decrease in wort pH due to the presence and interaction of Calcium ions
- Chemical interaction of other wort constituents
- Enzyme denaturation and inactivation at sparging

Malt Starches

Amylose

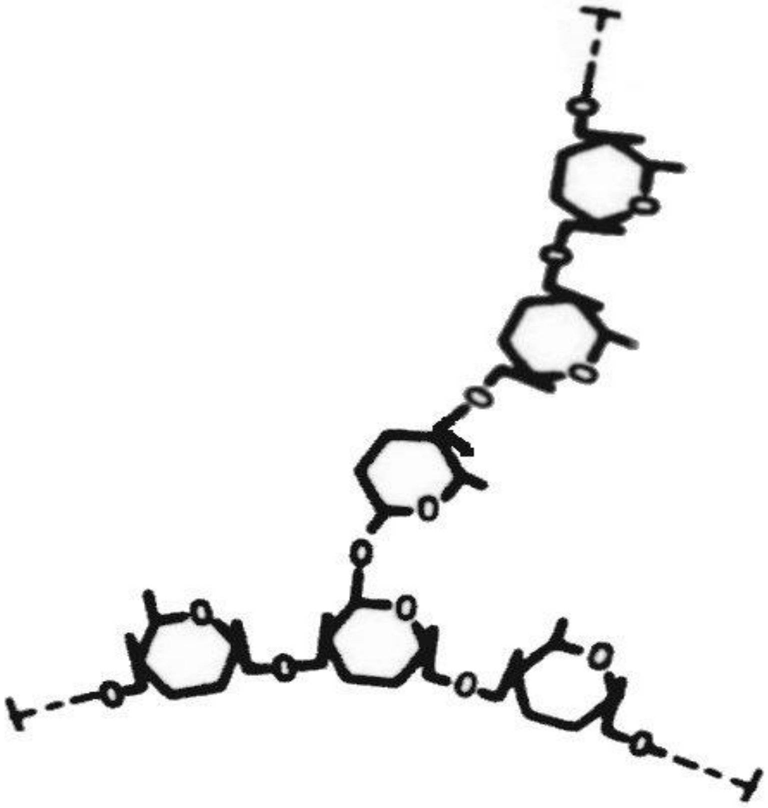


- 20 – 30% of the starch
- Straight chain polymer of glucose units
- α - (1,4) linkages
- Left hand terminus reducing
- Right hand terminus non-reducing

Malt Starches

Amylopectin

- 70 to 80% of starch
- Complex branched structure, branched on average every 27 glucose units
- α - (1,6) linkages at branches
- Only have 1 reducing terminus with non-reducing ones at the end of each branch



70 to 80% of starch

Complex branched structure, on average every 27 glucose units

α - (1,6) linkages at branches

Only have 1 reducing terminus but a non-reducing one at the end of each branch

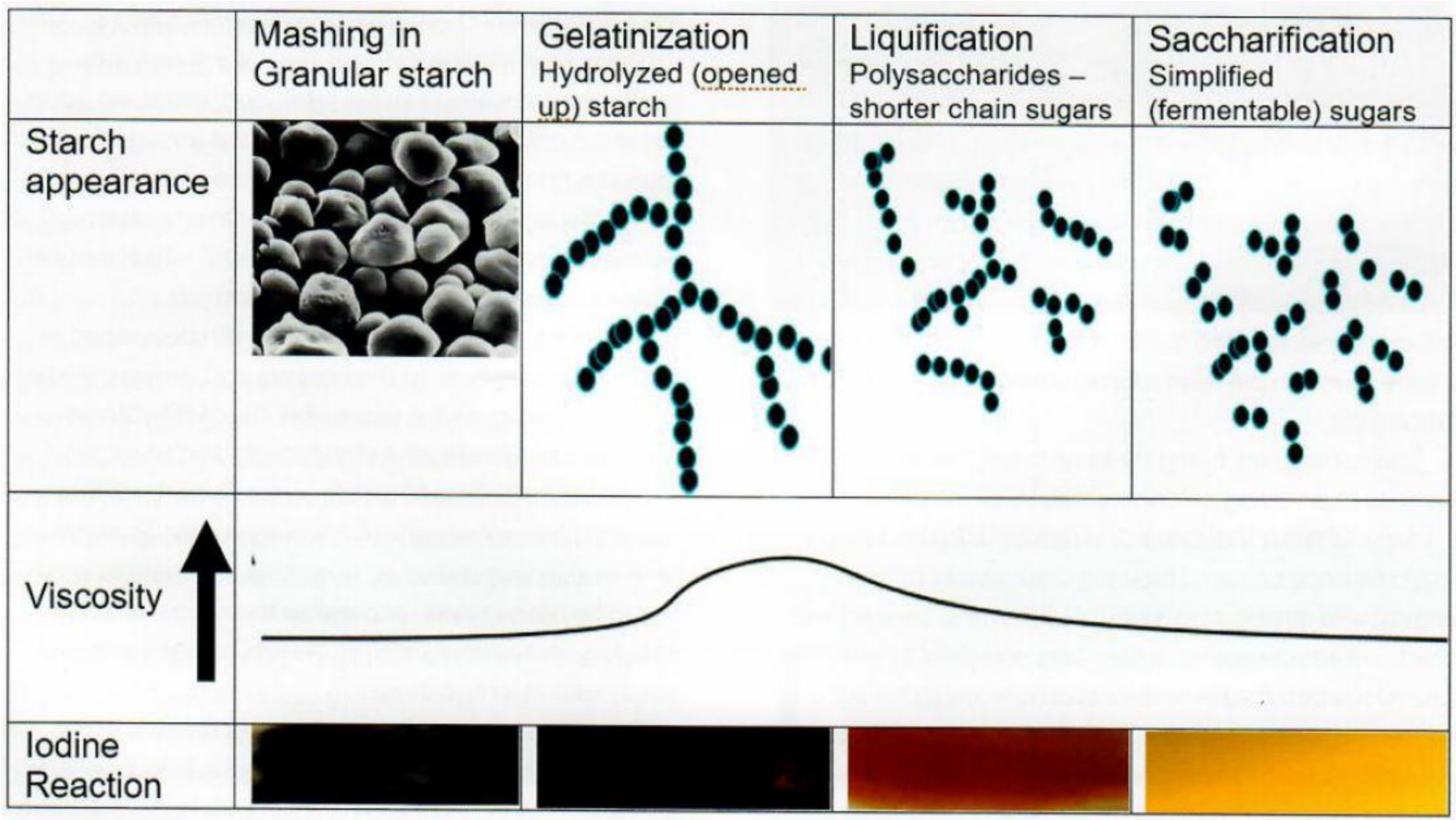
Amylolytic Enzymes
α - amylase

- Endo enzyme that breaks any α - (1,4) linkage in amylose and amylopectin
- Opens up starch molecules, dramatically reducing viscosity
- After gelatinisation temperature of 58 – 62 °C is achieved and starch structure is un-coiled, α - amylase quickly reduces the polymer size
- α - amylase liquefies starch
- Optimum temperature range 70 -75°C, pH 5.3 – 5.8

Amylolytic Enzymes
β - amylase

- Exo enzyme that breaks the chain at every second glucose at the non-reducing terminus
- Will fully reduce amylose but only 10 to 15% of amylopectin unless working with α-amylase because they only work at the non-reducing terminus
- Saccharifies starch producing maltose
- Optimum temperature range 63 - 65°C, pH 5.4 – 5.6

Starch Digestion During Mashing



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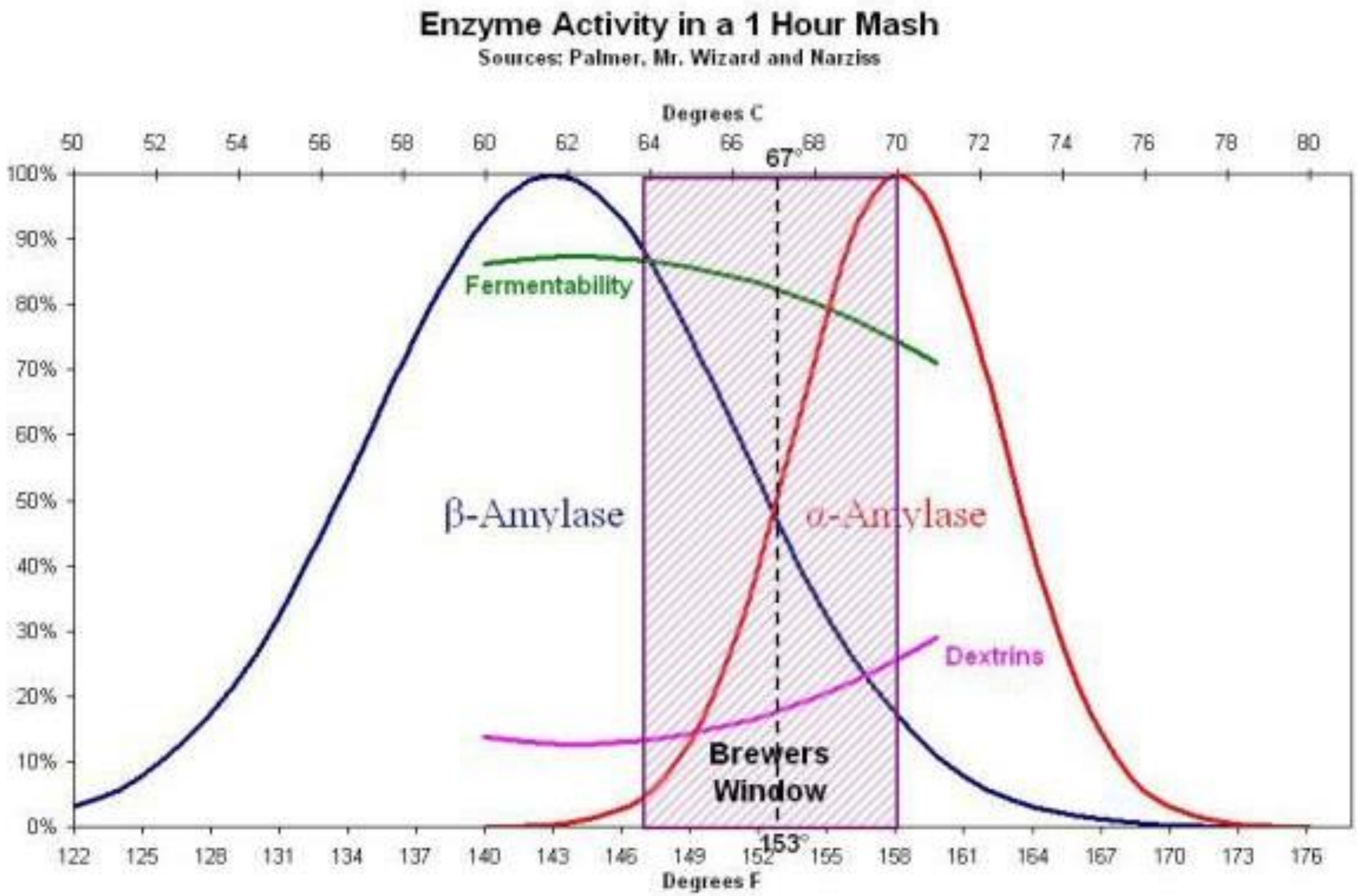
Practical Factors – Mash Temperature



Practical Factors – Mash Temperature

- **At 63°C mash temperature:**
  - β-amylase activity is high
  - low extract efficiency
  - high wort fermentability

- **At 65°C mash temperature:**
  - β-amylase activity begins to decline
  - α-amlyase activity starting
  - medium extract efficiency
  - average wort fermentability

- **At 68°C mash temperature**
  - β-amylase almost inactive
  - α-amlyase active
  - good extract efficiency
  - low wort fermentability

- **Sparging with liquor below 78°C or sparging for too long will increase fermentability as the α - amylase will not be inactivated**

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Practical Factors – Mash Thickness

- Thinner mashes cause enzyme de-naturation, particularly β-amylase, carboxipeptidase and protease
- Thicker mashes protect enzymes
- Watery mashes at 62 - 64°C will create more fermentable wort that will finish lower in gravity to produce lighter bodied beers
- Thicker mashes at 67 – 69°C will create less fermentable wort that will finish higher in gravity to produce fuller bodied beers
- Choose the appropriate mash thickness and temperature for the style of beer to be brewed

Practical Factors - pH

- The optimum pH for infusion mashes is 5.2 to 5.5 (measured at 20°C)

Optimal pH mashes:
- more rapid amylolytic starch degradation
- enhanced carboxypeptidase activity
- altered protein solubility and coagulability
- minimum tannin extraction

High pH mashes:
- poor saccharification and wort separation
- dark worts
- poor biological stability
- poor protein precipitation
- astringent beer

How to reduce mash pH:
- Use dark malts
- acidify with in-organic acids (phosphoric acid)
- acidify strike liquor (AMS, lactic acid)
- use brewing salts to increase calcium levels

Wort Composition - Carbohydrates

90 to 92% of total

- 50% maltose
- 13% maltotriose
- 10% glucose – some yeast are glucose repressant
- 25% dextrins – non-fermentable for most yeasts, but watch saison strains and brettanomyces
- Adding lactose, a milk sugar, to the kettle will give residual sweetness to the beer as yeasts cannot metabolise it

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Wort Composition - Nitrogen

3 to 6% of total

- Polypeptides – long chain sequences of amino acids
  hydrophobic ones promote beer foam
  acidic ones are haze sensitive

- Peptides – 2 to 10 amino acid units long, some can be metabolised by yeast, can contribute to body and mouthfeel in beer

- Free Amino Nitrogen – 10-15% of total soluble nitrogen – minimum of 140ppm in a 1.040°sg wort to ensure healthy yeast reproduction and timely fermentations

Wort Composition – Polyphenols

- 80% of wort polyphenols come from pro-anthocyanogens in the husk and underlying structures of malt grains
- Elevated pH and sparge temperatures increase polyphenol levels
- Oxidizable polyphenols can come through in beer if they aren't removed with stabilisers, they will complex with polypeptides to form hazes
- Crisp Clear Choice malt doesn't have any pro-anthocyanogens in the husk and sweet wort made from it has zero polyphenols
- Beers made with Clear Choice will be less astringent and more haze stable than those made with other malts

Wort Composition - Minerals

- Calcium

  - stabilises α-amylase

  - precipitates phosphate reducing pH

  - precipitates polypeptides reducing haze risk

  - precipitates oxalates reducing gushing risk

- Chlorides give perception of body and fullness

- Sulphates accentuate bitterness and are drying on the palate

- Traces of Zn, Na, PO4, Mn, Mg, K and Cu are all co-factors in yeast metabolism

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Thanks for Listening any Questions Please?