Malt – The Soul of Beer
Good Malt – Good Beer?

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Canadian Malting Barley Technical Centre
Good Beer

Characterized by:

• Flavour (taste, aroma, mouthfeel)
• Appearance (colour, clarity, foam)
• Wholesomeness (no hazardous compounds, presence of useful compounds)
Brewers Prefer Good Malt

• Increase their chances of professional and commercial success
• Right malt makes it easier for them to make good beer

Brewers have a real problem defining what good malt is!
What is malt?

• Barley grains that have been allowed to partially germinate
• Then they are heated
• Not dead, could re-germinate given the opportunity (water, air, time)
Key Processing Steps

Barley In ➔ Cleaning/Sizing ➔ Steeping – up to 48 hrs ➔ Germination 3-4 days ➔ Kilning - 24 hrs ➔ Malt Out ➔ Cleaning

- Humid cool air
- Dry hot Air
Steeping

- Most critical stage
- Adequate supply of water and oxygen
- Even moisture for homogeneous malt
Steeping
Steeping
Germination

Objectives

- Continues physiological activity started in steep
- Permits growth of embryo under controlled conditions
- Developing hydrolytic enzymes
- Breaks down cell walls completely, and proteins and starches partially
Germination
Germination
Kilning

Objectives

• Lowers the moisture of the green malt to 4-5%
• Stops germination gradually
• Removes undesirable flavors, develop appropriate colour and aroma
• Preserve adequate enzymes & fix the quality achieved during germination and early stage of kilning
• It takes up to 48 hours depending on type of malts
Kilning
What is malt?

• Malts fall into two categories, standard malts (pale malts) and specialty malts

• Standard malts provide bulk of extract, colour, flavour and yeast nutrients

• Specialty malts provide colour and flavour – while sacrificing extract and yeast nutrients
Malt Types and Products

Different types of barley malts

Pilsner Malt  Pale Ale Malt  Munich Malt  Crystal Malt

Caramel Malt  Amber Malt  Chocolate Malt  Black Malt
What is malt?

CAUTION

• Malt is substantially inhomogeneous
• Considerable differences from barley corn to corn
Why malt?

- Barley itself cannot be turned into beer
- Difficult to mill
- Lacks the levels of necessary enzymes for starch and protein conversion
- LACKS MALTY FLAVOUR
What does malt contain?

• Starch, protein, amino acids, peptides, phosphate, polyphenols, melanoidins, lipids, sterols, beta-glucan, vitamins, metal ions, and enzymes

• If not barley, we would need a number of other raw materials to provide the above. This would create difficulties in storing, keeping them separate, need to keep them dry and need to stabilize some of them with special treatments or chemicals
What does malt contribute to beer; the good?

<table>
<thead>
<tr>
<th>Character</th>
<th>Compounds Responsible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malty flavour</td>
<td>O and N-heterocycles</td>
</tr>
<tr>
<td>Sweetcorn flavour</td>
<td>Dimethyl sulphide (DMS)</td>
</tr>
<tr>
<td>Estery and Fusel flavours</td>
<td>Malt provides precursors for these materials (amino acids and sugars)</td>
</tr>
<tr>
<td>Colour</td>
<td>Melanoidins</td>
</tr>
<tr>
<td>Foam</td>
<td>Polypeptides</td>
</tr>
</tbody>
</table>
What does malt contribute to beer – the bad?

<table>
<thead>
<tr>
<th>Character</th>
<th>Compounds Responsible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-flavours</td>
<td>Smaller molecules including carbonyls, lipases, lipoxygenases</td>
</tr>
<tr>
<td>Safety Concerns</td>
<td>Nitrosodiumethylamine (NDMA), chlorophenols, aflotoxins, mycotoxins</td>
</tr>
<tr>
<td>Appearance problems (haze)</td>
<td>Proteins, polyphenols</td>
</tr>
<tr>
<td>Foam Problems (gushing)</td>
<td>Fusarium, vomotoxin</td>
</tr>
</tbody>
</table>
How does malt influence beer flavour?

Direct influence on sweet and sour taste

• Sweet derived from sugars – origin in malt starch
• Sour derived from inorganic acids – origin in germinating grain, produced by yeast from malt carbohydrates, grain microflora, release of phosphoric acid by malt derived phytic acid
How does malt influence beer flavour?

Malt provides us with huge variety of aroma-active compounds

• **Standard malts** - Malty, cereal, chaffy, powdery
• **Dark malts** – toffee, burnt, chocolate, roasted
• **Yeast may modify some malt components to produce sweet aroma**
• **DMS**
• **Amino acids give rise to a wide variety of aroma compounds, including higher alcohols and esters**
How does malt influence beer flavour?

Malt provides us with mouthfeel

• Degradation of starch to dextrins imparts mouthfeel or body to beer
• Beta-glucans may also influence mouthfeel
• Polyphenols can influence astringency
How does malt influence beer appearance?

**Colour**

• Two classes of compounds from malt impart colour, melanoidins and polyphenols
• Also malt contains polyphenol oxidase which increases malt colour
• Use of specialty malts – colour!
How does malt influence beer appearance?

Clarity

• Two main components in hazes, protein and polyphenol

• Malt and hops are the two sources of these compounds – proteins generally from malt although polyphenols can be extracted from husk material
How does malt influence beer appearance?

**Foam**

- Two main sources, protein and polyphenol
- Hops play a part in providing iso-alpha acids which crosslink these materials from the malt
How does malt influence beer appearance?

**Beer wholesomeness**

- Fantastic source of vitamins, fibre, trace metals, antioxidants
How does malt influence beer storage properties?

**Haze Stability**

- Beer develops chill hazes and permanent hazes during storage.
- Malt quality plays a role in this but brewing technology has evolved to minimize its impact.
- Use of hydrogels, xerogels, PVPP, papain to cross-link and remove the potential haze compounds common.
How does malt influence beer storage properties?

**Oxidative Flavour Stability**

• Malt has historically taken most of the blame for this.

• Compound blamed is Trans-2-Nonenol which has origins in oxidation of barley lipids during mashing process.

• Not the whole story in that other compounds and sources have recently been identified.
How does malt influence beer storage properties?

**Light Stability**

• Malt does play a part in this
• Hops are the major source although malt protein content, especially those sulphur containing amino acids and proteolytic activity contribute to light instability
How does malt influence beer storage properties?

**Foam Quality**

- Some beers suffer loss in foam quality during storage.
- This can be traced to the activity of yeast derived proteases whose substrates are malt derived.
How does malt influence the cost of beer production?

• Purchase cost of raw material (barley). Driven by yield which is closely linked to disease resistance, need for pesticides and fertilizer, climatic and agronomic considerations and marketplace.

• Cost of malting. Attributes which impact include dormancy, germinative capacity, vigour and the need for growth modifiers.
How does malt influence the cost of beer production?

• Losses in handling. Malt damage impacts on cost. Key control is grain moisture
• Brewhouse yield – amount of extract that can be recovered in the brewhouse
Malt analysis
Malt analysis - why set specifications?

- Basis for commercial transactions
- Prediction of brewhouse performance
Malt Analysis: Brewing Performance

- Only a few of the measured attributes are directly applicable to the wort – colour, FAN
- All of the other analyses are indirect and require inference by experience as to what the measurement means in the brewery
Malt Analysis Report VS Brewery Performance

Malt Analysis
- C/F Difference
- Turbidity
- Viscosity
- b-glucans
- Friability
- S/T Ratio
- Soluble protein
- FAN
- Alpha amylase
- DP
- Saccharification time
- Final Attenuation
- Wort Color
- Boiled Wort Color
- DMSP
- FG extract
- CG extract

Brewery Performance
- Mashing Performance
- Lautering Performance
  - (run off time)
  - (differential pressure)
  - (wort clarity)
  - (number of cuts/underlets)
  - (extract recovery)
- Attenuation
  - (consistency)
  - (end point)
- Yeast Health
- Yeast Flocculation Consistency
- Beer filterability
- Hazes and sediments

BEER TASTE
Measures of Carbohydrate Modification

Malt Analysis:
• Fine/Coarse extract differences
• Viscosity
• Beta-glucan
• Friability

Brewing Issues:
• Milling Problems
• Lautering Problems
  – Runoff rate, cuts, underlet
• Extract recoverability
• Attenuation achievement
Measures of Protein Modification

Malt Analysis:
• Total protein
• Soluble protein
• S/T ratio
• FAN
• pH

Brewing Issues:
• Yeast Nutrition
• RDF achievement
• Beer foam
• Beer flavour
• Beer filterability and physical stability
• Hazes and sediments
Measures of Enzyme Potential

Malt Analysis:
• Diastatic power
• Alpha amylase
• Limit Dextrinase

Brewing Issues:
• Attenuation achievement
• Attenuation repeatability
Measures of Carbohydrate Extract

Malt Analysis:
• Extract – coarse, fine, as is, dry basis
• Sieve assortment

Brewing Issues:
• Dollars and sense (cents!)
• Recoverability of the extract
Measure of Colour

Brewing Issues:
• Beer colour repeatability
• Colour influence on other malt attributes

Malt Analysis:
• Multiply malt colour by 1.2 to obtain beer colour
• So 0.1 malt colour change = 0.12 beer colour change
Brewing Performance

- Brewer must define what is important
- Brewer must be clear on what are the outcomes of the performance measure (positive and negative)
Brewing Performance

- Lautering Performance
- Attenuation
- Premature Yeast Flocculation (PYF)
- Non-Flocculation
- Attenuation Consistency
- Beer Filterability
- Physical Stability
Specialty Malts
Why specialty malt?

- Impart beer color
- Impart beer flavor
- Enhance non-biological stability of beer
- Improve beer head retention
Classification

No universally accepted classification is available (descriptions that follow must be viewed in this light)

By tradition and with reference to the ways in which they are produced

The divisions not wholly logical (specifications differ between localities and customers, as well as altered with time)
# Uses of Specialty Malts

<table>
<thead>
<tr>
<th>Malt type</th>
<th>Color °L</th>
<th>Beer type</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Row Pale</td>
<td>1.5 to 2.5</td>
<td>Most beers</td>
</tr>
<tr>
<td>6 Row Pale</td>
<td>1.5 to 2.5</td>
<td>Most beers</td>
</tr>
<tr>
<td>Vienna</td>
<td>4 to 6</td>
<td>Darker beer, Martzen</td>
</tr>
<tr>
<td>Pale Ale</td>
<td>2 to 4</td>
<td>Ale, Brown Ale</td>
</tr>
<tr>
<td>Munich</td>
<td>5 to 10</td>
<td>Dark lagers and ales</td>
</tr>
<tr>
<td>Caramel Pils</td>
<td>5 to 15</td>
<td>Dark lagers and ales</td>
</tr>
<tr>
<td>Caramel</td>
<td>8 to 120</td>
<td>Dark lagers and ales</td>
</tr>
<tr>
<td>Crystal</td>
<td>40 to 150</td>
<td>Paler ales</td>
</tr>
<tr>
<td>Amber</td>
<td>15 to 40</td>
<td>Barley wine, sweet Stout</td>
</tr>
<tr>
<td>Brown</td>
<td>40 to 60</td>
<td>Brown Ale, Stout, Porter</td>
</tr>
<tr>
<td>Chocolate</td>
<td>300 to 500</td>
<td>Stout, Porter</td>
</tr>
<tr>
<td>Black</td>
<td>400 to 600</td>
<td>Stout, Porter</td>
</tr>
<tr>
<td>Roasted barley</td>
<td>300 to 800</td>
<td>Irish Stout</td>
</tr>
</tbody>
</table>
A schematic summary of malt production

BARLEY

GREEN MALT

Low Temperature kilning <60°C

Stewed 55-70°C

Low Temperature Kilning 60-75°C

Normal Temperature Kilning 85-115°C

High Temperature Kilning Drum roasted 85-115°C

Drum roasted 120-160°C

Drum roasted 220-230°C

Pilsner Malt
Enzymatic Malt

Pale Ale Malt
Vienna Malt
Munich Malt

Black Malt
Chocolate Malt
Brown Malt

Crystal Malt

Roasted Barley
The Malt Academy is the only facility in the Americas to gain experience in understanding the malting process. Utilizing the state-of-the-art CMBTC 100 kg Pilot Malthouse and Joe White Micro-malting Unit participants will gain the theoretical as well as practical hands-on knowledge required to understand the malting process and understand its’ effect on brewing and beer.

Our instructors have over 100 years in practical malting and brewing experience and a limited class size add to the opportunity to truly learn the process. The programs are of use to brewers that wish to better understand the soul of their beers to those maltsters wishing to upgrade their skills, or to learn the craft.

CMBTC offers two programs in the Malt Academy, each designed to provide the optimum learning experience.
3 Day Malting Program

A hands-on course aimed to give participants theoretical and hands-on practical knowledge of malting technology, and to understand the source and manufacture of the primary raw material of beer, malt, and the factors that influence its quality and the impact on brewery performance.

PROGRAM

• World Barley Origins
• Barley Morphology and Structure
• Barley Selection
• Barley Analysis
• Handling and Storage of Malting Barley
• Malting Overview
• Malting Biochemistry
• Malt Analysis
• Brewing 101
• Matching Malt Specification to Brewing Performance
• Practical Problems
• Demonstration on Barley Selection, Barley Analysis, Micro-malting and Pilot Malting
2 Week Intensive Malting Program

A course aimed to give participants theoretical and hands-on practical knowledge of malting technology to understand the source and manufacture of the primary raw material of beer, malt, and the factors that influence its quality and the impact on brewery performance.

PROGRAM

- World Barley Origins
- Barley Breeding and Selection
- Barley Morphology and Structure
- Barley Analysis
- Handling and Storage of Malting Barley
- Malting Overview
- The Detailed Process
  - Cleaning and Steeping
  - Germination
  - Kilning
- Malt Analysis
- Specialty Malt Production
- Malting Biochemistry
- Malt Analysis

- Brewing 101
- Matching Malt Specification to Brewing Performance
- Practical Problems
- Environmental Sustainability
- Hands-on Barley Selection, Barley Analysis, Micro-malting and Pilot Malting
Thank you