Breakdown of a Malt COA

Bucket Analysis Approach
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Great Western Malting
Breakdown of a Malt COA

Agenda

Overview of Malting and Modification

Certificate of Analysis Breakdown

Bucketing Analysis
  • Protein Dependent Specifications
  • Carbohydrate Dependent Specifications
  • Enzyme Package Specifications
  • Color
Breakdown of a Malt COA

Malting and Modification

Breakdown of COA

Bucketing Analysis
Malting and the Certificate of Analysis

• Malting is the controlled germination and kilning of a seed to produce the desirable brewing characteristics.

• Maltsters create ideal growing conditions for barley to germinate and drive **modification**.

• “Modification” is the biochemical breakdown of cell wall structures, and protein matrices in order to gain access to the starch reserves held within the endosperm.

• A malt Certificate of Analysis (COA) lists the results from a suite of standardized tests that serve to indicate how the malt will perform.
Breakdown of a Malt COA

Malting and Modification

Breakdown of COA

Bucketing Analysis
Malt Sieve Analysis (Assortment)
- Plump kernels provide more extract than thinner kernels
- Roller mill gaps are set according to the mean kernel size
  - A broad distribution can make mill setting difficult → poor extract recovery in the brewery
- Typical analysis – 7/64 + 6/64’s (PLUMP’s) > 90%
- Consistency is the key

Malt Sieve Analysis (Breakage)
- Damaged husks will form a poor filter bed
- Fines formed due to breakage → Slow run-off
- Dust and fines have a negative impact on malt silo housekeeping
- Peeled and broken malt kernels can lead to false (apparent) increase in extract
Breakdown of the COA

Malt Moisture

- Impacted by all process including degree of kilning
- Poor kilning may imply that other malt analysis (Color, DMS-P) will be out of specification
- Malt with very high moisture (>9%) may show a rapid decline in quality during storage
- Higher moisture = Lower Extract,
- Lower moisture = Higher Breakage
  - Typical 2 Row Base Malt Analysis → 3.8-4.6 %
Breakdown of the COA

**Extract**
- Many contributing factors to the amount of extract available for a brewer
- Typical analysis for Fine Grind Dry Basis → 79-84%
- Typical analysis for Coarse Grind Dry Bases → 77-83%

**Fine/Coarse Difference (F/C)**
- Fine Grind % minus Coarse Grind %
- Typical analysis → 0.5-1.5 %
- Larger F/C Difference indicates lack of homogeneity in malt
  - Potential under modification, glassy portions of kernels

**Color**
- Color generation occurs during the kilning of green malt
- Control of color through malting practices, kilning regime and blending
- 95%+ of beer color contribution is malt
  - Remaining 5% Maillard reaction of amino acids, sugars during boiling

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Breakdown of the COA

**Wort Viscosity**
- Broad correlation with wort run-off times in brewery and potential haze problems
- Measures Beta-Glucans, pentosans, and proteins combined
- Typical analysis < 1.6, normally → 1.44-1.52

**Beta Glucan (BG)**
- Malt with a laboratory wort BG figure of <140 will most likely show signs of quicker run off rates and better beer filtration rates
- Above 140 BG, there is a high potential for lautering and filtration issues
- Typical analysis → <120 mg/L, this year <100 mg/L
Breakdown of the COA

**Diastatic Power (DP)**
- For most craft brewers, DP >115 will provide sufficient enzymes to process the mash
- Higher levels of enzymes support:
  - Increased attenuation (reduced residual dextrins)
  - High levels of adjunct addition
  - High gravity brewing

**Alpha (α) Amylase (AA)**
- α-amylase progressively breaks open the chains of amylose and amylopectin to form dextrins containing 7 to 12 glucose residues.
- For most brewers with normal levels of unmalted grains or adjuncts, >50 AA is more than enough for breakdown of starch into simple sugars

**Starch degrading enzymes not individually reported:**
- β-amylase
- Limit dextrinase

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Free Amino Nitrogen (FAN)

- FAN is the term for amino acids, which have been either freed or broken down from barley protein during germination
- Composed of various low molecular weight proteins
- Important for yeast nutrition
- Greater malt modification directly contributes to higher FAN in finished malt

- Insufficient FAN (<150mg/L)
  - Poor yeast growth
  - Slow or incomplete fermentations
- Excess FAN (>250 mg/L)
  - Utilized by other micro-organisms and converted into negative flavor compounds
  - More problematic in packaged beer and is less of a concern if your beer sells in a pub or tap room
  - Contributes to increased color formation during wort boil
Breakdown of the COA

**Soluble Protein (% dry basis)**
- Measure of protein that has been solubilized during the malting process
- Water soluble → extracted into mash
- Lower molecular weights

**Total Protein (% dry basis)**
- Total Protein (%) = Total Nitrogen (%) x 6.25
- Lower protein malt
  - Higher extract
  - Lower enzymes
- Higher protein malt
  - Lower extract
  - Higher enzymes
  - Important for higher adjunct levels, high gravity brews and when targeting low residual dextrins
  - More foam positive
- Total protein is reduced slightly during malting
  - Removal of rootlets post-kiln
- Total protein content strongly influenced by weather

### Malt Analysis

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<td>81.0</td>
<td>13.4</td>
<td>3.1</td>
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- Moisture, %: 4.08
- Extract %, finely ground malt, as is: 79.0
- Extract %, finely ground malt, dry basis: 82.3
- Extract %, coarsely ground malt, as is: 78.0
- Extract %, coarsely ground malt, dry basis: 81.4
- F/C Difference %: 1.0
- Color, laboratory Wort, ASBC method: 1.91
- Viscosity: 1.44
- Beta Glucan, ppm: 61
- Diastatic Power: 129
- Alpha Amylase (DU): 65.4
- Free Amino Nitrogen (mg/L): 211

- Total Soluble Protein %, dry basis: 5.32
- Total Protein %, dry basis: 11.47
- S/T Ratio %: 46.4
- Friability: 89.9
- Homogeneity: 98.9
- Whole Kernel: 0.3
Breakdown of the COA

S/T Ratio (%)

- S/T = Soluble Protein / Total Protein
- Normal values for base malt between 42 - 46%
  - Higher for some specialty malts 45 - 52%
  - Lower for classic pilsner malts 39 - 42%
- Somewhat challenging to interpret
  - As Total Protein increases – S/T ratio decreases even if soluble protein remains constant.
  - As Total Protein decreases – S/T ratio increases even if soluble protein remains constant.
- Strong measure of modification – especially for protein consistent malt streams

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Friability
- Typical analysis > 80%
- Strong predictor of malt modification
- Low values indicate under-modification
  - Benefit from lower temperature mashes to favor the action of thermally sensitive β-glucanase and proteolytic enzymes
- High values indicate complete modification

Homogeneity
- Typical analysis > 90%
- Measure of uniformity of modification
- Very important as a descriptor for friability and malt quality
Maltsters control moisture content, temperature, air flow and time in order to achieve the desired level of modification.

Broadly Speaking...

**Lower Modified Malts**
- Lower Free Amino Nitrogen
- Reduced color formation
- Increased foam potential
- Increased β-glucan
  - Slower wort separation
  - Increased mouthfeel

**Higher Modified Malts**
- Higher Free Amino Nitrogen
- Increased color formation
- Decreased foam potential
- Decreased β-glucan
  - Thinner beer
  - Less mouthfeel
Breakdown of a Malt COA

Malting and Modification

Breakdown of COA

Bucketing Analysis
Breakdown of the COA

**Bucket 1 – Protein Modification**

Has there been adequate digestion of the barley protein into usable soluble protein?

- Nutrients for yeast → Free Amino Nitrogen (FAN)
- Mid size proteins → Body and Foam
- Large size proteins → Haze

**Analysis**

- S/T Ratio
- Free Amino Nitrogen
- Total Protein
- Soluble Protein

**Winner**

- S/T Ratio
Breakdown of the COA

Bucket 2 – Carbohydrate Modification

Has there been adequate digestion of the cell wall, so that it is friable for milling, protein is accessible, and extract is free flowing?

- Breakdown of dense carbohydrate structures, and long chain starches

Is there good quality recoverable extract? Can we get consistent attenuation?

Analysis
- Fine Coarse Difference
- Viscosity
- Beta Glucan
- Friability

Winner
- Beta Glucan
Breakdown of the COA

Bucket 3 – Enzyme Potential

Not so concerned with development of enzymatic potential but rather the preservation of them!

- Prior to kilning → 180 DP
- After kilning → >120 DP (1/3 or more of DP denatured or damaged)

- By slowly increasing temperatures (115 °F to 150 °F) as moisture decreases to below 30%, we are able to stabilize enzymes. thereby preventing denaturing from occurring.

- Enzymes are in excess of what brewers require

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**ENZYME** | **LETHAL TEMPERATURE** | **COMMENT**
--- | --- | ---
α-amylase | <80 °C (176 F) | Most stable enzyme
β-amylase | 65 – 70 °C (149-158 F) | Thermally sensitive

**Analysis**
- Diastatic Power
- Alpha Amylase

**Winner**
- Diastatic Power

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Breakdown of the COA

- Each measurement on a COA also informs you about other aspects of the malt
- Brewers should know to request actual Lot COAs, rather than typical COAs
- Invisible strings connect each of the 20+ analysis
- Each brewery is configured differently. Figure out what *is important to you* and focus on those aspects of your malt analysis. Monitoring things that don’t matter won’t help.

The Winners

- S/T Ratio
- Beta Glucan
- Diastatic Power
- Color
- Extract

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Thank you!