Malt Specifications for the Practical Brewer

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What are Specifications?

- A detailed description used to minimize miscommunication
- Examples include:
  - Product specifications, e.g., malt specifications
  - Engineering/design specifcations
  - Functional specifications

How Are Specifications Used by Buyers?

- Communicate requirements & expectations to supplier
  - Bid packages
  - Purchase orders
  - Acceptance criteria
- Understand how to use a product
  - New beer formulation
  - Ingredient subsitutions
  - Equipment installation

How Are Specifications Used by Suppliers?

- Define products
  - Manufacturing control
  - Marketing & sales
  - Acceptance criteria
- Explain how to use a product
  - New beer formulation
  - Ingredient subsitutions
  - Equipment installation

Same Specification, Different Products

Malt Specifications vs. Certificates of Analysis

- A specification applies to a type of malt, for example Rahr Pale Ale malt

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Malt Specification vs. Certificate of Analysis

- A specification applies to a type of malt, for example Rahr Pale Ale malt
- A Certificate of Analysis applies to a particular lot of malt
- Many brewers refer to a complete set of malt analyses as "malt specs." This can lead to confusion about what is being discussed.

Malt Specifications Defined

Overview of Specs

Physical Analyses

- Assortment
- Bushel Weight
- Friability
- Moisture Content

Biochemical Analyses

- Diastatic Power (DP)
- Alpha Amylase (DU)
- Deoxynivalenol (DON)

Overview of Specs

Compositional Analyses

- Extract – Fine Grind
- Extract – Coarse Grind
- Fine/Coarse Difference
- Color
- Total Protein
- Soluble/Total (Kolbach Index)
- Free Amino Nitrogen (FAN)
- Beta Glucan
- Viscosity

Moisture Content

Method

- Determined by weighing before and after drying finely milled sample in a drying oven.

Significance

- Malt stability issues when greater than ~6%
- Very dry malt is more susceptible to damage
- Generally less in highly kilned malts
- Brewers don't like paying for water

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Normal base malt range is 3-5%

Fine Grind Extract, As-Is

Method

- 50 g finely milled malt
- 200 ml distilled water
- 45ºC for 30 minutes, 25 minute ramp to 70ºC, 100 ml 70ºC water added, 60 minute hold, cool to ambient, and adjust total sample weight to 450 grams.
- Total mash time = 115 minutes
- Total water is 400 grams (8:1 water to grist ratio)
- Transfer to filter, collect wort, and measure density

Trivia Question ... What is this thing?

Fine Grind Extract, As-Is

Significance

- Determine highest possible yield
- Decreases with protein content
- Used in conjunction with coarse grind extract as indicator of modification
- Wort from this method is used for all wort analyses that are used to describe malt (color, pH, FAN, etc.)

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Normal base malt range is 76-82%

Coarse Grind Extract, As-Is

Method

- 50 g coarsely milled malt
- 200 ml distilled water
- 45ºC for 30 minutes, 25 minute ramp to 70ºC, 100 ml 70ºC water added, 60 minute hold, cool to ambient, and adjust total sample weight to 450 grams.
- Total mash time = 115 minutes
- Total water is 400 grams (8:1 water to grist ratio)
- Transfer to filter, collect wort, and measure density

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- Represents yield more typical for brewery conditions
- Basis for brewhouse yield determination
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Normal base malt range is 75-81.5%

Brewhouse Yield Calculation

Given:

- 1,985 liters of hot wort
- 12.2º Plato;1.049 kg/l
- 335 kg malt used
- CG (as-is) = 77.5%

Kg Extract = (1,985 x 0.96 x 0.122 x 1.049) = 244 kg extract

Material Yield = 244 ÷ 335 x 100 = 72.8%

Brewhouse Yield = 72.8 ÷ 77.5 x 100 = 93.9%

l°/kg … Huh?

Given:

- 1,985 liters
- SG = 1.049 (49°)
- 335 kg malt used
- loB Extract = 310 l°/kg

l° Produced = (1,985 l x 49°) = 97,265 l°

Material Yield (l°/kg) = 97,265 l° ÷ 335 kg = 290 l°/kg

Brewhouse Yield = 290 ÷ 310 x 100 = 93.6%

Extract, Dry Basis

Method

- Determine malt moisture and extract as-is

Dry Basis Extract = (100 x As-Is Extract) ÷ (100 – % Moisture)

Assume Coarse Grind, As-Is = 78% at 4.2% moisture

Coarse Grind, Dry Basis = (78 x 100) ÷ (100-4.2) = 81.4%

Fine/Coarse Difference

Method

- $FG_{(db)} - CG_{(db)} = C/F$ Difference

Significance

- General index of modification related to cell wall degradation during malting

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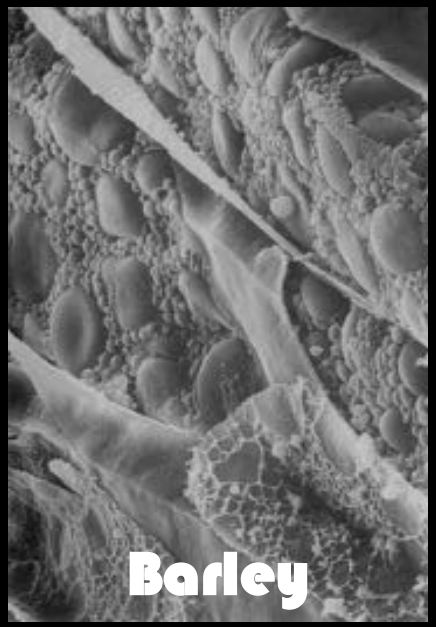
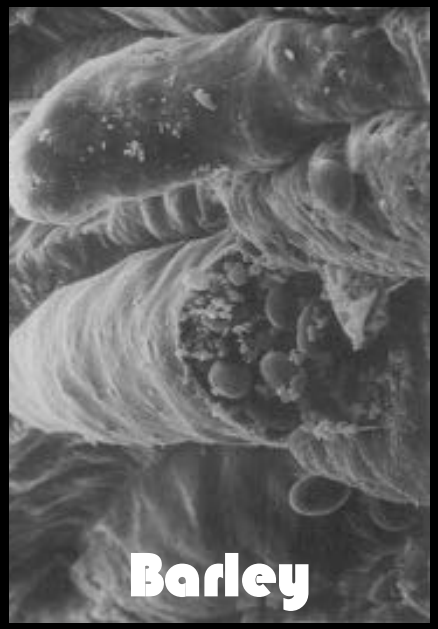
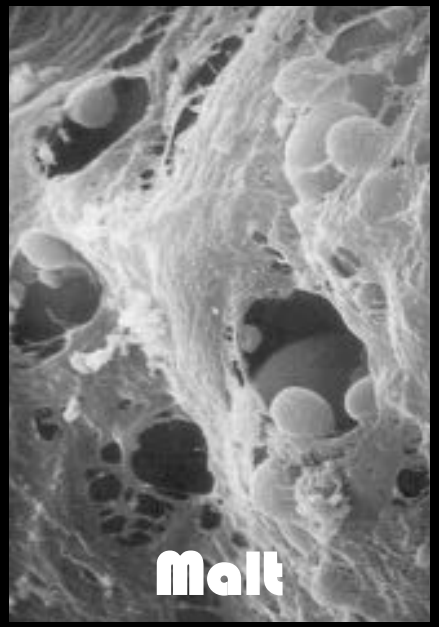
Normal base malt range is 0.5-1.5

Cell Wall Degradation During Malting







Turbidity

Method

- Congress wort sample measured for haze using nephelometer

Significance

- Typically associated with proteins and beta glucans not degarded after mashing
- May indicate residual starch after mashing
- Red flag for downstream clarity issues in finished beer

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Normal base malt
NTU < 15

pH

Method

- Congress wort sample measured for pH. Note that Congress mash is made using distilled water and is very dilute.

Significance

- General indicator of mash pH
- Decreases with malt color
- Low wort pH can come from burning sulfur on the kiln

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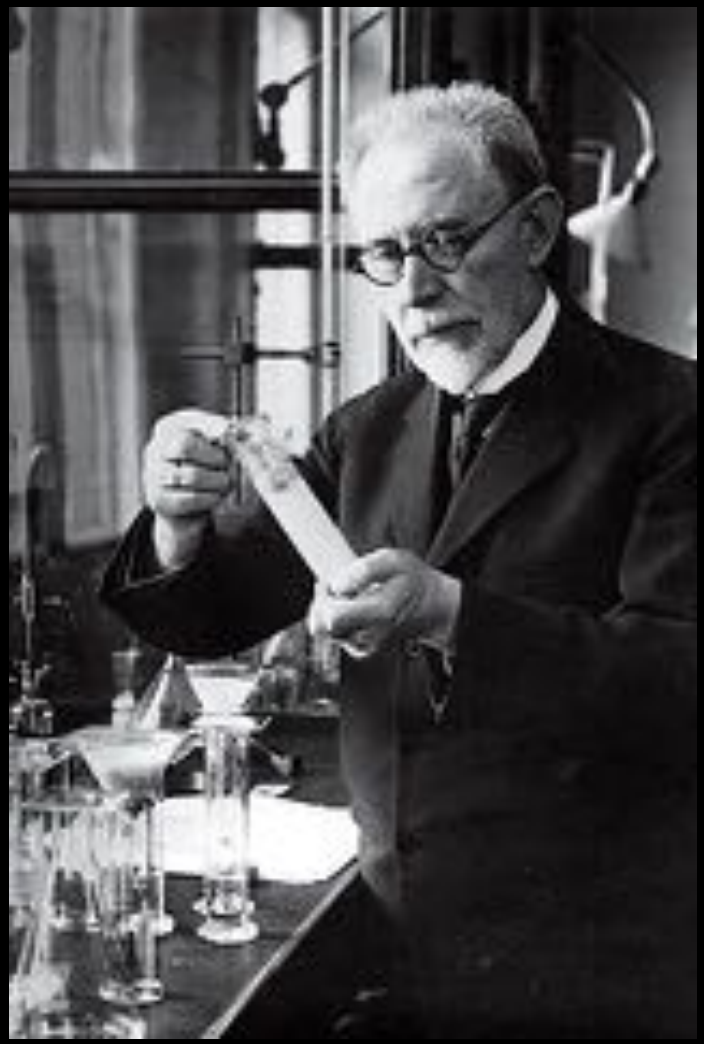
Normal base malt range pH 5.6 - 6.1

Two-Part Trivia Question …

1. Who developed the concept of pH and the pH scale?

2. Where did this scientist work and what was his role when he developed the pH scale?



Color (SRM)

Method

- Use wort produced from fine grind, Congress mash
- Measure absorbance of clear wort* at 430 nm in 10 mm cuvette, diluting if required for dark worts

SRM Color = $A_{(10@430nm)}$ x 10 = ^{0}Lovibond

EBC Color = SRM x 1.97

*Wort is deemed to be clear when $A_{(10@430nm)}$ x 0.039 < $A_{(10@700nm)}$

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Normal base malt range 1.5 - 5.0°L

Color (SRM)

Key Points

- Congress wort gravity is ~8^0 Plato, so value needs to be adjusted for brewery wort gravity when used in calculations
- Wort color increases during boiling and usually decreases during fermentation
- Malt color is related to malt flavor
- Changes in beer color can signal a change in beer flavor, even when there is no flavor difference

Total Protein

Method

- Determine nitrogen content (wt/wt) in malt using either the Kjeldahl method or combustion method
- % Protein = 6.25 x %N

Significance

- Enzymes are proteins
- Extract decreases as protein increases
- Foam and haze are related to malt protein

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Significance

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Normal base malt range is 9–12.5%

Soluble Protein

Method

- Rapid method using Congress wort that measures UV light absorbance by proteins at 215 nm and 225 nm
- Standardized using the Kjeldahl method

Significance

- Indication of proteolysis during malting and mashing
- Index of modification, but without referring to total protein, soluble protein does not tell the whole story
- Very useful control parameter for the maltster

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Trivia Question … Who Was Johan Kjeldahl?

S/T or Kolbach Index

Method

- Ratio of soluble protein to total protein

Significance

- Index of modification
- High values are associated with decreased foam stability
- High values are associated with ease of use in brewhouse

S/T or Kolbach Index

Method

- Ratio of soluble protein to total protein

Significance

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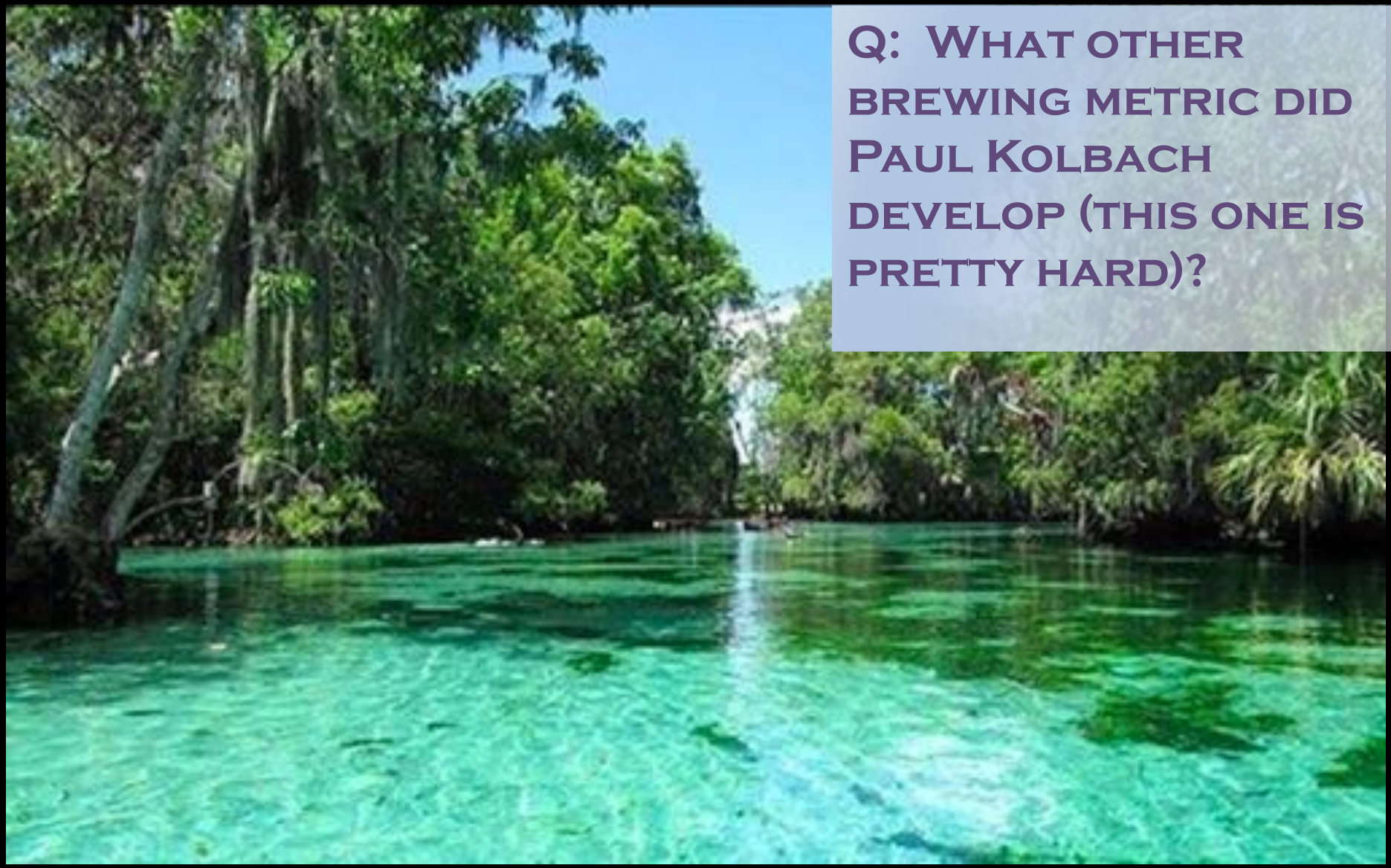
- High values are associated with decreased foam stability
- High values are associated with ease of use in brewhouse

Normal base malt range is 35-48%

Bonus Trivia Question …



Q: What other brewing metric did Paul Kolbach develop (this one is pretty hard)?

Free Amino Nitrogen (FAN)

Method

- Amino acids, ammonia, and alpha-amino nitrogen (protein and polypeptide ends) stain blue-purple with ninhydrin
- Color measured at 570 nm

Significance

- Primarily used as an indicator of amino acids available to yeast, but this is not a specific measure and does not differentiate among amino acid groups
- Related to beer stability

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Significance

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- Related to beer stability

Normal base malt range 160-240 mg/l

Beta Glucan

Method

- Calcofluor, a fluorescent dye that binds to carbohydrate gums, is added to wort from Congress mash, 365 nm light is used for excitation, and 420 nm is used to measure emitted light

Significance

- Index of modification related to cell wall degradation
- Method measures high molecular weight beta glucan (>~100kD), but signal is not affected by molecular weight

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Normal base malt <150

Viscosity

Method

- Congress wort viscosity is measured using an Ostwald or Cannon-Fenske tube viscometer

Significance

- Index of modification related to cell wall degradation
- Indicator of wort flow properties through mash bed

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Significance

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Normal base malt range is < 1.8 cP

Deoxynivalenol (DON)

Method

- Enzyme-linked immunosorbent assay (ELISA) using monoclonal antibodies specific to DON

Significance

- DON is a mycotoxin with FDA-regulated limits established for wheat and barley
- Commonly called vomitoxin
- Commercial malts well below the FDA limit

Diastatic Power (DP)

Method

- Standard starch is added to ambient water extract of malt sample, and reducing sugars quantified by reacting with ferricyanide solution and subsequent titration with thiosulfate

Significance

- Measures total amylolytic enzyme activity of malt
- Process control in relation to RDF and adjunct ratios

$^0WK = (3.5 \times {}^0Lintner) - 16$

100^0 Lintner = 334^0 WK (Windisch-Kolbach)

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Should be ~60°L+ for base malt

Dextrinizing Units (DU)

Method

- Special beta-limit starch is added to ambient water extract of malt sample, and time required to dextrinize starch is determined in the presence of excess beta-amylase using potassium iodide as color indicator

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Significance

- Measures alpha amylase activity of malt
- Process control in relation to RDF and adjunct ratios

Should be ~30+ for base malt

Assortment

Method

- 100 gram malt sample separated on $^{7}/_{64}$", $^{6}/_{64}$", $^{5}/_{64}$" screens into these three fractions and a "thru" fraction

Significance

- Important consideration for mill adjustment; changes in assortment should flag gap tests
- Kernel plumpness is related to husk fraction and "husky attributes" in finished beer; plump kernels have more endosperm

Bushel Weight

Method

- 110 gram malt sample poured using special funnel apparatus into volumetric container. Assume 214 ml for example.

BW = 8,545/volume of sample = 8,545/214 = 40 lb/bu

lb/ft^3 = 40 lb/bu ÷ 9.25 gal/bu x 7.48 gal/ft^3 = 32.3 lb/ft^3

kg/hl ≅ BW x 1.2872 = 40 x 1.2872 = 51.5 kg/hl = 515 kg/m^3

Significance

- Silo and conveyor sizing

Friability

Method

- Malt sample is crushed using special friability instrument and further separated on secondary screen; the retained material represents undermodified bits of endosperm and whole kernals (reported as two numbers).

Significance

- Especially useful in conjunction with other indices
- Flag by breweries to change mashing and lautering profiles

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Normally >90%

What Specs Don't Talk About

- Beer Flavor
- Malt condition in silo
- Malt condition into mill
- Grist assortment after milling
- Brewery extract
- Water chemistry
- Brewery mash conditions

Thank you!

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