Malt Specifications for the Practical Brewer

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Ashton Lewis

BSG Manager of Training & Technical Support
BYO Technical Editor/Mr. Wizard

- ✓ BSG/Rahr Malting 2016 - Present
- ✓ SBC Master Brewer 1997 - 2019
- ✓ Paul Mueller Company 1997-2016
- ✓ Joined BYO Team in 1995
- ✓ Started homebrewing in 1986
- ✓ MS in Food/Brewing Science - UC Davis in 1994
- ✓ BS in Food Science - Virginia Tech in 1991

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What are Specifications?

- A detailed description used to minimize miscommunication

- Examples include:
  - Product specifications, e.g., malt specifications
  - Engineering/design specifications
  - Functional specifications

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How Are Specifications Used by Buyers?

- Communicate requirements & expectations to supplier
  - Bid packages
  - Purchase orders
  - Acceptance criteria

Features

- 14.9 psig Non-ASME Code
- 100°F Design Temperature
- 70° Bottom Cone Angle
- 2 Cooling Zones on Shell
- 1 Cooling Zone on Cone
- 1 Thermowell
- 3" of Insulation
- Fully Welded 12 Gauge Stainless Steel Outer Jacket
- Inswing Manway
- Removable CIP Assembly
- Racking Arm

Finish Options:

- # 4 Polished Interior Finish
- # 4 Polished Exterior Finish

Tank Trim:

- 2-Hole RLV Assembly
- Combination Pressure / Vacuum Relief
- Rotary Spray Ball Upgrade
- Butterfly & Sample Valves
- Pressure Gauge
- Stainless Steel Fermentation Airlock

Leg Options:

- Adjustable Base Plates
- Base Plate Tank Jack

How Are Specifications Used by Suppliers?

- Define products
  - Manufacturing control
  - Marketing & sales
  - Acceptance criteria
- Explain how to use a product
  - New beer formulation
  - Ingredient substitutions
  - Process specifics, e.g., mashing

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WEYERMANN® SPECIALTY MALTS

PRODUCT SPECIFICATION

Product: Weyermann® Isaria 1924® **Crop: 2021**

Made from the oldest German malting barley variety Isaria. With its origin in Bavaria, Isaria was officially approved for the beer production in 1924 and instantly became a success.
Isaria was used by brewers to brew traditional flavorful Lagers such as Keller (cellar), Märzen and Zoigl beers. This famous heirloom malt is now available as Weyermann® Isaria 1924.
Sensory: malty-sweet taste and soft biscuit like aroma; soft mouthfeel.
Enzyme activity: medium

Raw Material: Malting quality barley

Source: Germany, EU

Ingredients: Barley
Water

Recommended Quantities: Brewery
Food Industry as required

Usage: Zoigl Beer; Franconian Landbier; Kellerbiere; Maerzenbier; Festbiere; Munich Dunkel; Pale Bock; Dark Bock;

The following values are subject to harvest-specific variations. All analyses are performed by independent, certified laboratories according to MEBAK "Brew-Technical Analysis Methods".
The color of the Caramel- and Roasted Malts is measured by the Hellige Neo-Komparator as the reference method.

Parameter:	Minimum:	Maximum:	Unit:
Moisture content		5	%
Extract (dry substance)	78		%
Color (EBC)	7	9	EBC
Color (Lovibond)	3.1	3.8	Lovibond
Protein (dry substance)	11	13	%
Kolbach Index	31	43	%
Hartong Index 45°C	33	43	%
Saccharification time		15	min
Viscosity (8.6%)		1.58	m Pa s
Friability	75		%

Valid after: 2021-10-27
www.weyermannmalt.com

Same Specification, Different Products

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Malt Specs versus COA

- A specification applies to a type of malt, e.g., Rahr North Star Pils

RAHR MALTING CO.

Shakopee Shipment Specifications

Crop Year 2021

		2R Malted Barley	Premium Pilsner	North Star Pils	Pale Ale
Moisture (FOB basis)	%	4.5 max	4.5 max	5.0 max	4.5 max
Extract (FGDB)	%	79.0 min	79.0 min	78.0 min	79.0 min
Color	SRM	1.90-2.50	1.80-2.30	1.50-2.00	2.70-4.80
Protein	%	13.0 max	13.0 max	12.5 max	13.5 max
Kolbach Index	%	39.0-47.0	39.0-47.0	37.0-44.0	
Plump (7/64"+6/64")	%	85.0 min	85.0 min	85.0 min	85.0 min
Thru 5/64"	%	2.0 max	2.0 max	2.0 max	2.0 max
FAN	ASBC	160-235	160-235	150-215	175 min
Diastatic Power	ASBC	120-160	120-160	120-180	95 min
Alpha Amylase	ASBC	55.0-75.0	55.0-75.0	55.0-70.0	58 min
Beta Glucan	ppm	140 max	140 max	150 max	150 max

Malt Specs versus COA

- A specification applies to a type of malt, e.g., Rahr North Star Pils
- A COA (Certificate of Analysis) applies to a particular lot of malt

Issued: 22 Oct, 2021

1847

RAHR MALTING CO.

RAHR MALTING CO. SHAKOPEE, MN 55379

952-496-7117 (Theresa Kukar) - Please contact QCshakopee@rahr.com for support

Certificate Of Analysis

Customer	Ship Date	Car Number	Grade	Destination
BREWERS SUPPLY GROUP	10/20/2021	WAT 271	North Star Pils	WREN HOUSE BREWING

Shipment Wt. Lbs.	Rahr Ref No
47,954	0039696

Crop Year	Variety	Percent
	AMBA Approved Barley	100

Assay	Methodology	Shipment	Min Spec	Max Spec
Moisture, %	ASBC-Malt-3	4.49		5.00
Fine Grind, As Is, %		77.6		
Fine Grind, Dry Basis, %	ASBC-Malt-4	81.2	79.0	99.0
Fine/Coarse Difference, %	ASBC-Malt-4	1.0		2.0
Coarse Grind, As Is, %		76.6		
Coarse Grind, Dry Basis, %	ASBC-Malt-4	80.2	77.5	99.9
Color, SRM	ASBC-Wort-9	1.55	1.50	1.90
Diastatic Power, ºLintner	ASBC-Malt-6C	120	110	150
Alpha Amylase, DU	ASBC-Malt-7D	58.1	55.0	70.0
Total Protein, %	ASBC-Malt-8B	11.21		
Soluble Protein, %	ASBC-Wort-17	4.54	4.00	5.40
S/T Ratio		40.5	38.00	43.00
Viscosity, cP	ASBC-Wort-13B	1.50		1.55
Beta Glucan, mg/L	ASBC-Wort-18B	115		150
DON, mg/L		0.08		0.50
FAN, mg/L	ASBC-Wort-12B	185	150	200
pH	ASBC-Wort-8	5.89		
7/64	ASBC-Malt-2B	75.0		
6/64	ASBC-Malt-2B	19.0		
5/64	ASBC-Malt-2B	5.4		
Thru	ASBC-Malt-2B	0.6		1.0
Turbidity, NTU		7.9		
Friability	ASBC-Malt-12	87.8		
Friability %WK	ASBC-Malt-12	0.14		
Bushel Weight, lb/bu	ASBC-Malt-2A	40.8		

Theresa Kukar

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Specs v. COA

Many brewers refer to a complete set of malt analyses as "malt specs." This can lead to confusion about what is being discussed.

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Shakopee Shipment Specifications

Crop Year 2021

		2R Malted Barley	Premium Pilsner	North Star Pils	Pale Ale
Moisture (FOB basis)	%	4.5 max	4.5 max	5.0 max	4.5 max
Extract (FGDB)	%	79.0 min	79.0 min	78.0 min	79.0 min
Color	SRM	1.90-2.50	1.80-2.30	1.50-2.00	2.70-4.80
Protein	%	13.0 max	13.0 max	12.5 max	13.5 max
Kolbach Index	%	39.0-47.0	39.0-47.0	37.0-44.0	
Plump (7/64"+6/64")	%	85.0 min	85.0 min	85.0 min	85.0 min
Thru 5/64"	%	2.0 max	2.0 max	2.0 max	2.0 max
FAN	ASBC	160-235	160-235	150-215	175 min
Diastatic Power	ASBC	120-160	120-160	120-180	95 min
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Turbidity, NTU		7.9		
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Friability %WK	ASBC-Malt-12	0.14		
Bushel Weight, lb/bu	ASBC-Malt-2A	40.8		

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Specs ≠ COA

Overview of Specs – Physical and Biochemical Analytics

- ✓ Assortment
- ✓ Bushel Weight
- ✓ Friability
- ✓ Moisture Content

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

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Overview of Specs – Compositional Analytics

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

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Analytics Most Useful to the Small-Scale Practical Brewer

Don't Assume that Malt is Constant

Coarse Grind Extract, As-Is

<u>Method</u>

- 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 g
- Total mash time = 115 minutes
- Total water is 400 grams (8:1 water to grist ratio)
- Transfer to filter, collect wort, and measure density

Coarse Grind Extract, As-Is

Significance

- Represents yield more typical for brewery conditions
- Basis for brewhouse yield determination
- Decreases with protein content
- Used in conjunction with fine grind extract as indicator of modification

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%

Calculated:

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

Material Yield = 244 kg extract ÷ 335 kg malt x 100 = 72.8%

Brewhouse Yield = 72.8 ÷ 77.5 x 100 = 93.9%

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

What's the Scoop?

Based upon the data below about what you want to do with water and the grist bill for this beer, the salt additions to the right are suggested. The water volume also includes a diluent suggestion if the plan is to dial back any ion(s) present in your base water.

Suggested acidulated malt, lactic acid, and phosphoric acid dose rates are also shown to the right to help achieve the your mash goals. The ~Mash pH is a prediction based on grist composition, water chemistry profile, and one of the acid additions (all equivalent).

This is a Summary of Your Water "Recipe"			Adjusted Profile		Suggested Acid Additives (Choose One)	
City Water	349.2 liters	3.0 BBL	Ca^{+2}	100 ppm	% Acidulated Malt	0.72%
RO Water	824.1 liters	7.0 BBL	Na^{+}	30 ppm	88% Lactic Acid	0.5 g/kg grist
$CaSO_4$	242 g	8.54 oz.	Mg^{+2}	15 ppm	75% Phosphoric Acid	0.5 g/kg grist
$CaCl_2$	158 g	5.56 oz.	SO_4^{-}	157 ppm	~Mash pH Based on Water and Acid Corrections (these values should all be the same)	
NaCl	31 g	1.09 oz.	Cl^{-}	63 ppm		
$MgSO_4$	73 g	2.58 oz.	HCO_3^{-}	50 ppm	~ Mash pH with Acidulated Malt	5.60
$NaHCO_3$	0 g	0.00 oz.	Cl^{-}: SO4-	0.4 :1	~ Mash pH with Lactic Acid	5.60
Total Water	1,173 liters	10.0 BBL	RA	-2.2 °dH	~ Mash pH with Phosphoric Acid	5.60

What are you doing in the mash?

Malt Type	Base Malt pH (see COA)	Crystal Malts	Light Roasted Malts	Dark Roasted Malts	Acidulated Malt	Target Mash pH
Usage Rate (% of total extract)	5.8	2.5%	0.0%	0.0%	0.0%	5.6

Mash pH ~ Base Malt pH +(°RA x 10/0.3) - (% crystal x 0.025) - (% light roast x 0.030) - (% dark roast x 0.050) - (% acidulated x 0.1)

Acid Additon Rules

88% Lactic Acid
@ 65.9g/100kg grist
Reduces Mash pH by ~0.1

75% Phosphoric Acid
@ 74.8g/100kg grist
Reduces Mash pH by ~0.1

Source:
Siebel Institute Lectures

How much brewing water do you need (mash + sparge)?

Total Volume	10.0	BBL	11.7 hL	1,173 liters

What's in your water ("as-is profile")?

Ion	Ca^{+2}	Na^{+}	Mg^{+2}	SO_4^{-}	Cl^{-}	HCO_3^{-}	Cl^{-}: SO4-	RA	~ Mash pH
ppm	12	66	30	60	15	168	0.3	6.3 °dH	5.93

Normal base malts pH 5.6 – 6.1

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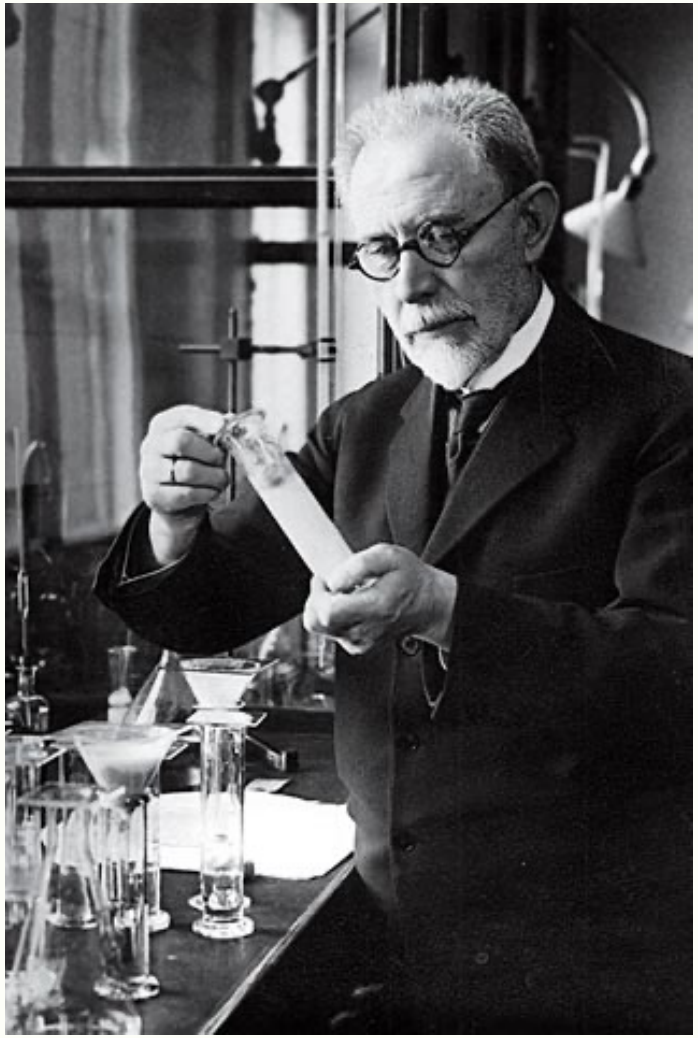
Brewing Science Trivia!

- Søren Sørensen developed the concept of pH and the pH scale in 1909.
- Sørensen was the head of the Carlsberg Brewing Laboratories from 1901 to 1938.



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Color (SRM)

<u>Method</u>

- 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 = ºLovibond

EBC Color = SRM x 1.97

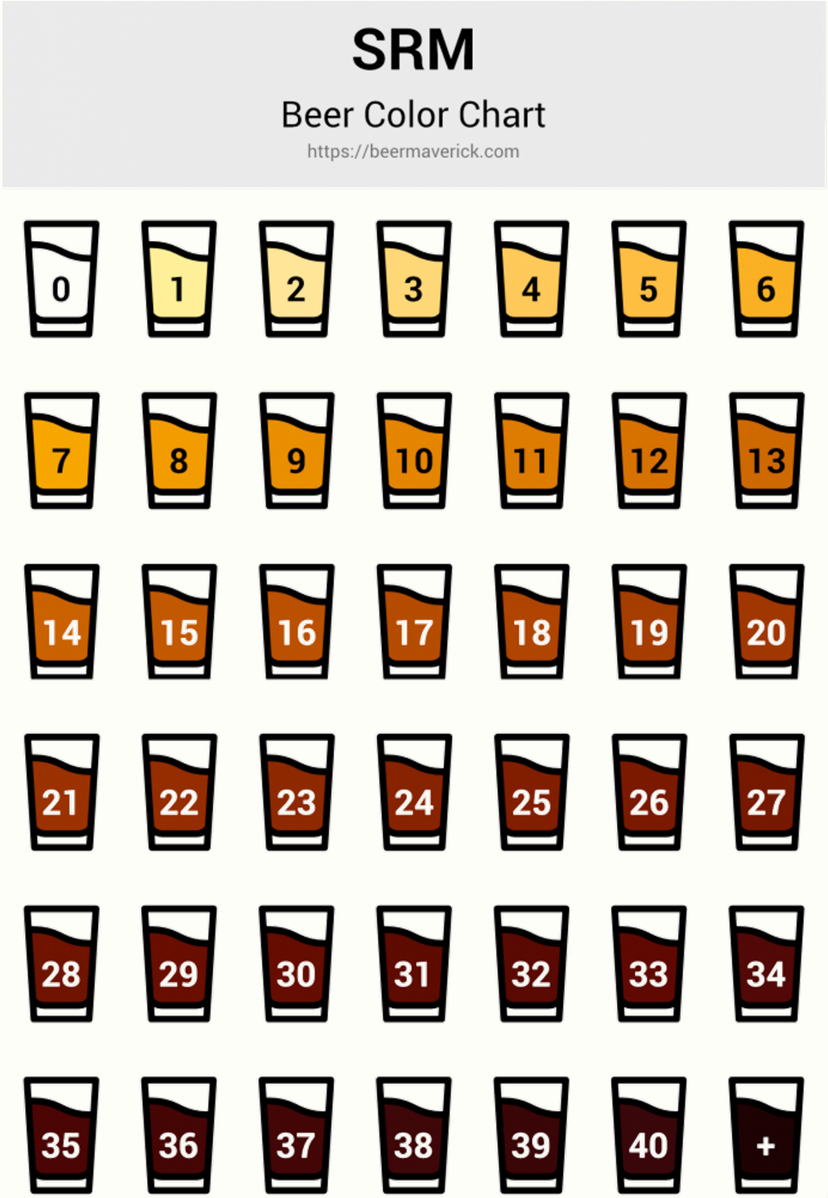
*Wort is deemed to be clear when $A_{(10@430nm)} \times 0.039 < A_{(10@700nm)}$

Normal base malt range 1.5 – 5.0ºL

Color (SRM)

<u>Key Points</u>

- Congress wort gravity is ~8º 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



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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

Normal base malt range is 9-12.5%

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Johan Kjeldahl

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S/T or Kolbach Index

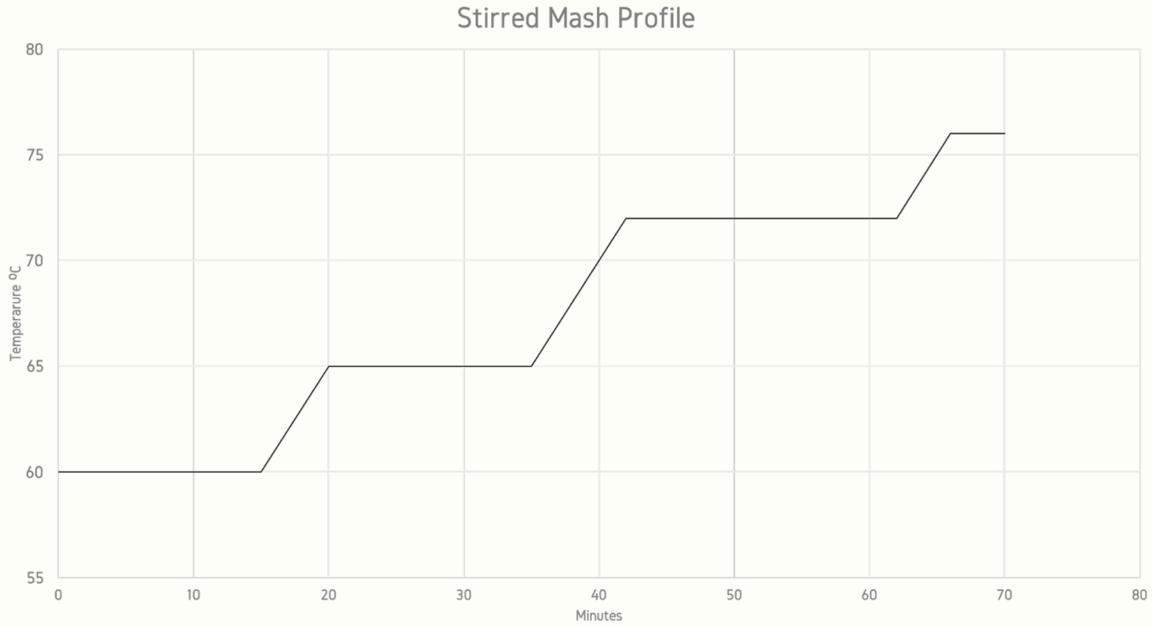
Method

- 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

Normal base malt range is 35-48%



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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
- Related to beer stability

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Normal base malts
160-240 mg/l

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

- ºWK = (3.5 x ºLintner) – 16
- 100º Lintner = 334º WK (Windisch-Kolbach)

> 60ºL+ 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

Significance

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

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Should be
~30+ for base malt

Assortment

<u>Method</u>

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

<u>Significance</u>

- Important consideration for mill adjustment; changes in assortment should flag gap tests
- Kernel plumpness is related to husk fraction

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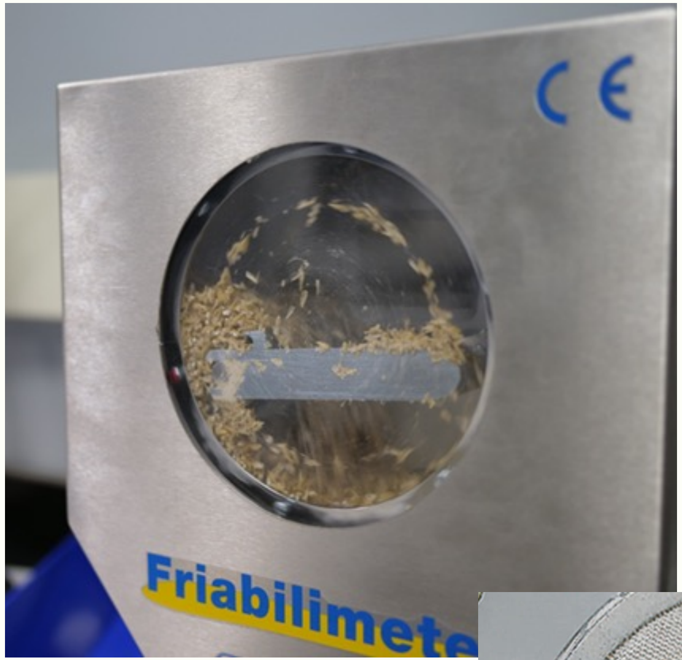
Friability

Method

- Malt sample is crushed using special friability instrument and further separated on secondary screen.

- Significance
- Useful in conjunction with other indices
- Flag by breweries to change mashing and lautering profiles



Normally >90%

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The Rest of the COA

Meaningful and useful data, but not the numbers that most brewers used to set their brewing clocks.

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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

Normal base malt range is 3-5%

Fine Grind Extract, As-Is

<u>Method</u>

- 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 g
- 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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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.)

Normal base malt range is 76-82%

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Dry-Basis Extract

<u>Method</u>

1. Determine malt moisture and as-is extract
2. Calculate dry-basis extract
    - Dry Basis Extract = (100 x As-Is Extract) ÷ (100 - % Moisture)

<u>Example</u>

- Assume Coarse Grind, As-Is = 78% @ 4.2% moisture
- Coarse Grind, Dry Basis = (78 x 100) ÷ (100-4.2) = 81.4%

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Fine/Coarse Difference

Method

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

Significance

- General index of modification related to cell wall degradation during malting
- Not very meaningful with well-modified malts because the value is often less than the extract measurement error

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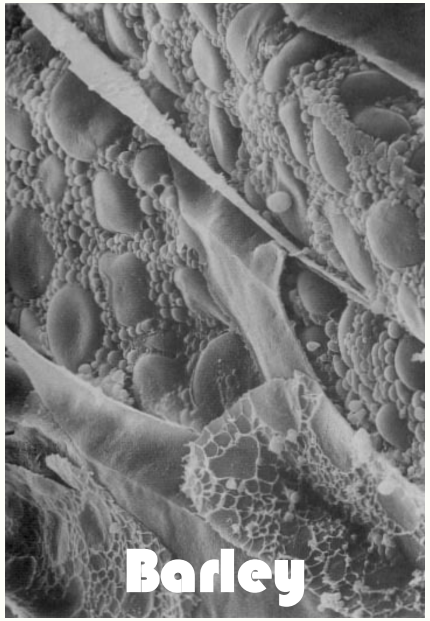
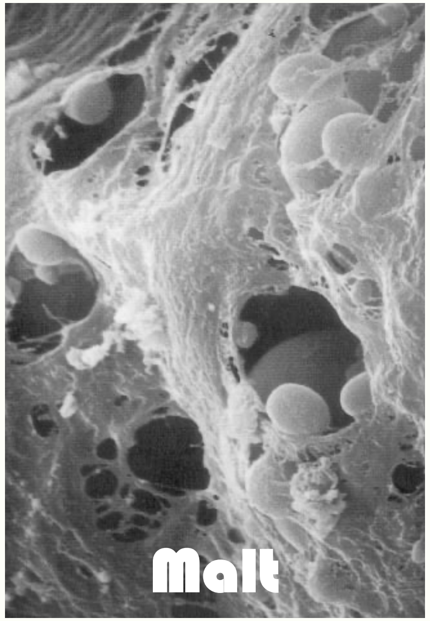
Normal base malt range is 0.5-1.5

Cell Wall Degradation During Malting





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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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Normal base malt range is 3-6%

Turbidity

Method

- Congress wort sample measured for haze using nephelometer

Significance

- Typically associated with proteins and beta glucans not degraded 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

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

<u>Method</u>

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

<u>Significance</u>

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

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
- Commercial malts well below the FDA limit

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

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What Specs Don't Talk About

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

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BSG Tech Tips

Malt Sensory & Physical Analysis by Hand

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Malt Chewing & Observation

- Quick and easy method
- Requires training and imagination to relate malt flavor to beer flavor
- Great for weeding out samples when developing new beers
- Limited use for calculations

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Hot Steep Method

- Simplified mini-mash requiring no special equipment
- Quick way to produce wort for sensory evaluation
- Great way to compare several malts of a single type, e.g., Pilsner base malts

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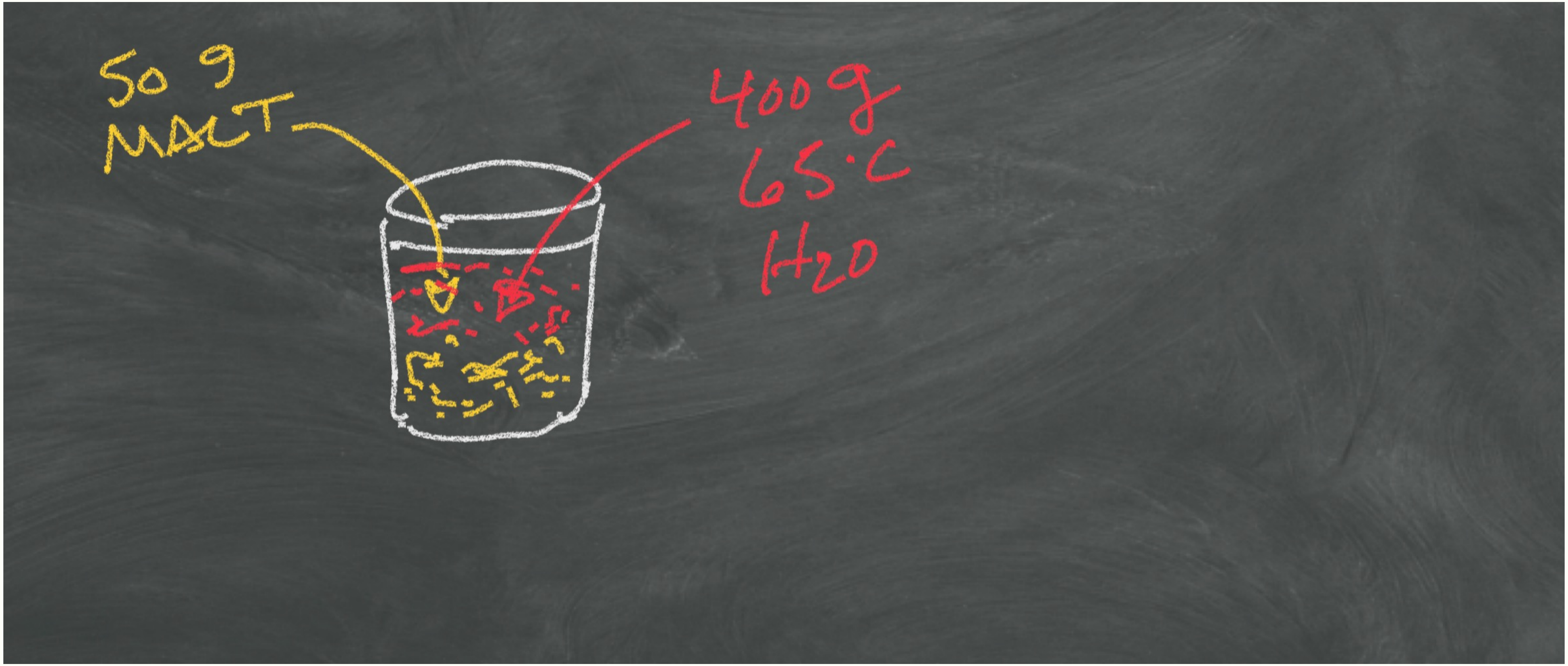
Hot Steep Method



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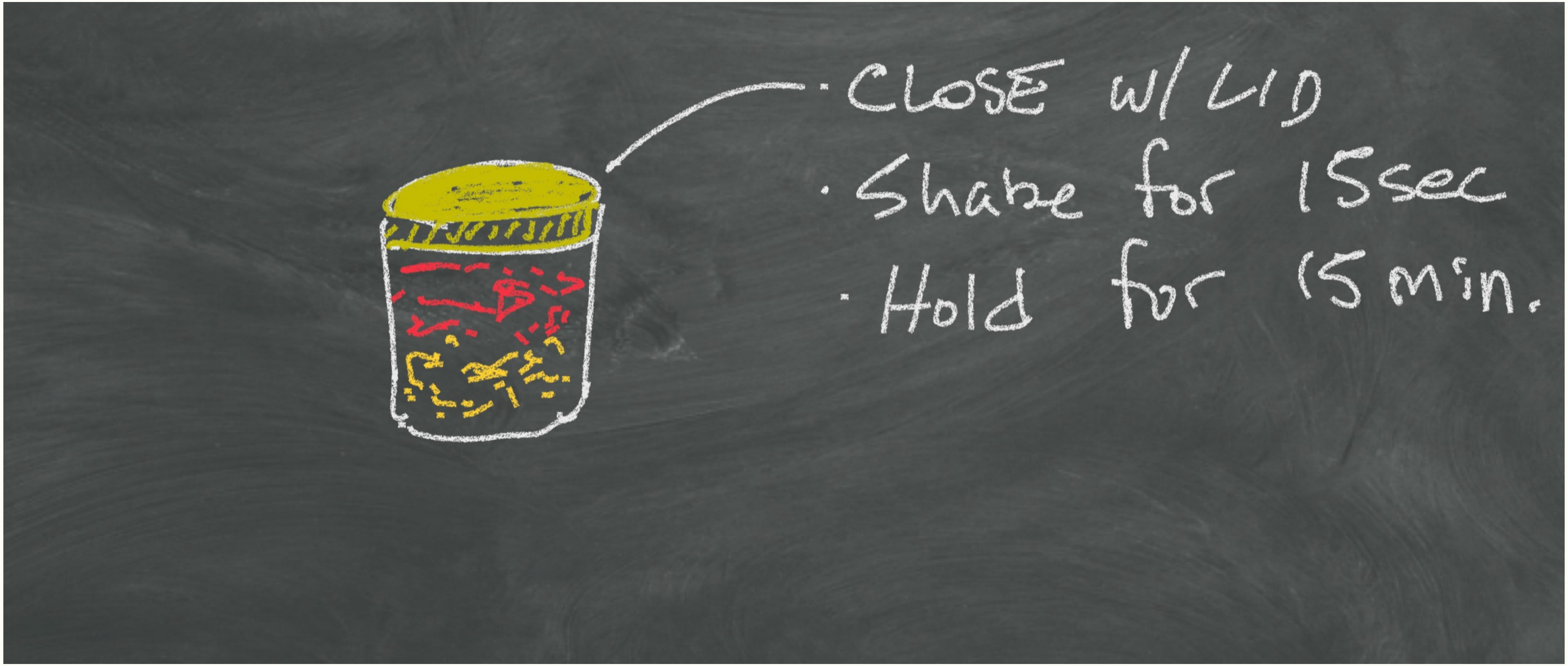
Hot Steep Method



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Hot Steep Method

Pilot Brewing

- Malt evaluation is really all about beer.
- The best way to know for certain how malt works for brewing is to brew!
- Lots of opinions about the scalability of pilot brews, but breweries of all sizes do use pilot brewing and it is a valuable tool.

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The Importance of Being Choosey

- Main source of fermentable extract
- Provides enzymes needed to convert starch to sugars
- Husk of barley malt is used as a filter during wort collection
- Flavor, color, appearance, and mouthfeel are all affected by malt

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Thank You!

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