How Good Is Your Grist?

National Homebrew Conference
June 14, 2014
Grand Rapids, Michigan

Jennifer Helber
Grain to Glass, LLC
North Kansas City, Missouri
• M.S. in Microbiology
• Established Boulevard Brewing Co.’s Quality Assurance Lab, 1999-2008
• Member of the American Society of Brewing Science; Sensory Committee
• Judge for GABF since 2006
• BJCP Judge since 2009
• Chair of Technical Subcommittee which ran a collaborative on the Manual Sieve Method
• Homebrewer since 2006
• Graduate of Siebel’s Advanced Homebrewing Course, 2009
• ZZ Hops President, 2010-2012
• Member of KC Biermeisters

• Currently, Microbiologist for the USDA, at the National Grain Center in KCMO

More background
Owner/President of a local Homebrew supply/Bottle Shop--
**Grain to Glass, LLC**
(established 2012),
in North Kansas City, Missouri
Beers and malts
We prepare recipes while homebrewers enjoy a beer!
Malting Science
Barley is Best

- It has a **husk** that protects the germ
- High starch-to-protein ratio
- Complete enzyme system
- Light color
- Neutral flavor
Milling: Definitions or objectives

Mill(v) to grind into a grist, flour, meal or powder

Milling ultimately is a compromise that each brewmaster reaches with a batch of grain. Their objectives are to find an acceptable middle ground between:

- Yield
- Separation Efficiency (Lautering)
- Quality
What’s a Mill?

Mill(n) a machine or apparatus for grinding grain
Roller Mills, 2, 4, 5 or 6...
Different homebrewer mills
Milling: Making the most of your Grist

Grain Type/Assortment

Mill settings

Grind Profile

Brewhouse Performance
Pilsen Malt WK

**Typical Analysis**

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wort / Grain</td>
<td>93% / 2%</td>
</tr>
<tr>
<td>Plump</td>
<td>90%</td>
</tr>
<tr>
<td>TPA</td>
<td>2%</td>
</tr>
<tr>
<td>Moisture</td>
<td>4.5%</td>
</tr>
<tr>
<td>Extract at 2.5% Moist</td>
<td>88%</td>
</tr>
<tr>
<td>Extract at 2.5% Dry</td>
<td>78.0%</td>
</tr>
<tr>
<td>Extract FOM Difference</td>
<td>2.0%</td>
</tr>
<tr>
<td>SPG (FOM/ROG)</td>
<td>11.2</td>
</tr>
<tr>
<td>G/T</td>
<td>37.6</td>
</tr>
<tr>
<td>Alpha Amyloglucan</td>
<td>45.6</td>
</tr>
<tr>
<td>Diastatic Power Whirl</td>
<td>120</td>
</tr>
<tr>
<td>Color</td>
<td>1.6</td>
</tr>
</tbody>
</table>

**Kosher Certification**

Utik, Pareve

**Flavors**

Crisp Malt, Delicately Sweet

**Uses and Packaging Options**

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilsen Malt, WK</td>
<td>50 pound bag</td>
</tr>
<tr>
<td>Call for #</td>
<td>2,000-pound tote</td>
</tr>
<tr>
<td>Pilsen Malt, WK</td>
<td>bulk</td>
</tr>
</tbody>
</table>

**Storage and Shelf Life**

Best if used within 6 months from date of manufacture. Store at temperatures of 30°F.

**Characteristics and Applications**

- Very light colored base malt.
- Produces exceptionally clean, crisp beer.
- Pilsen Malt has a slightly lower protein level than 2 Row Brewers Malt.
- Produced from AMIB/MBIBRI recommended 2 Row Malting Barley varieties.

The data listed under typical analysis are subject to the standard analytical deviations. They represent average values, and to be considered as guarantees, expressed or implied, are at the condition of sale. The product information contained herein is correct to the best of our knowledge. As the statements are intended only as a source of information, no statement is to be construed as vesting any patent or copyright.

February 2004
Recommended Sieves

- No 14........ 1.40mm opening
- No 30........ 0.600mm opening
- No 60........ 0.250mm opening
- Pan
- Cover

Balances

- Portable Balance
- Capacity Minimum 500gms
- Readability 0.1g – 1 g
Grist Profile Methods

Standard Sieve Test

This procedure is for the classification of malt grist from mill grinding by sieve analysis. The method employs a mechanical shaker for sieving a quantity of grist through standard sieves.

Ro-Tap Sieve Shaker
The Rotap Testing Sieve Shaker accurately reproduces the circular and tapping motion given testing sieves in hand-sieving, but with a uniform, mechanical action assuring dependable, comparable tests.

Tyler Coarse Sieve Shaker
This low cost shaker is designed to be used in coarse testing application. Well suited for preground grist evaluation. A specially designed mechanism provides a shaking action resulting in consistent, accurate results.
<table>
<thead>
<tr>
<th></th>
<th>Standard Ro-Tap Method</th>
<th>Standard Shaker Method</th>
<th>Manual Sieve Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ro-Tap Shaker</td>
<td>$1695.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coarse Sieve Shaker</td>
<td></td>
<td>$1000.00</td>
<td></td>
</tr>
<tr>
<td># 14 Sieve</td>
<td>$29.99</td>
<td>$29.99</td>
<td>$29.99</td>
</tr>
<tr>
<td># 30 Sieve</td>
<td>$29.99</td>
<td>$29.99</td>
<td>$29.99</td>
</tr>
<tr>
<td># 60 Sieve</td>
<td>$29.99</td>
<td>$29.99</td>
<td>$29.99</td>
</tr>
<tr>
<td>Pan</td>
<td>$19.70</td>
<td>$19.70</td>
<td>$19.70</td>
</tr>
<tr>
<td>Cover</td>
<td>$14.95</td>
<td>$14.95</td>
<td>$14.95</td>
</tr>
<tr>
<td>Balance</td>
<td>$144.00</td>
<td>$144.00</td>
<td>$144.00</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td><strong>$1963.62</strong></td>
<td><strong>$1268.62</strong></td>
<td><strong>$268.62</strong></td>
</tr>
</tbody>
</table>
Sieve analysis

**NORMAL GRIND**

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 Sieve</td>
<td>53.4%</td>
</tr>
<tr>
<td>30 Sieve</td>
<td>27.6%</td>
</tr>
<tr>
<td>60 Sieve</td>
<td>10.6%</td>
</tr>
<tr>
<td>Pan</td>
<td>8.4%</td>
</tr>
</tbody>
</table>
## Optimizing Example

### Brewhouse Collection

<table>
<thead>
<tr>
<th>Mill settings</th>
<th>Yeild efficiency</th>
<th>Retained Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse</td>
<td>64%</td>
<td>85% 96</td>
</tr>
<tr>
<td>Normal</td>
<td>68%</td>
<td>91% 94</td>
</tr>
<tr>
<td>Fine</td>
<td>69%</td>
<td>92% 143</td>
</tr>
</tbody>
</table>

### Roller Gap Retained

<table>
<thead>
<tr>
<th>Mill settings</th>
<th>Roller Gap Retained</th>
<th>Mill settings</th>
<th>top</th>
<th>middle</th>
<th>bottom</th>
<th>Retained</th>
<th>14</th>
<th>30</th>
<th>60</th>
<th>pan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse</td>
<td>13.0 10.5 11.0</td>
<td>78 14 4 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>10.0 8.0 6.0</td>
<td>53 28 11 8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fine</td>
<td>6.5 3.3 2.8</td>
<td>25 25 31 20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Mill settings

- Coarse
- Normal
- Fine
Malt Grist by Manual Sieve Test

CONCLUSIONS

RESULTS AND DISCUSSIONS

The size of the opening and characteristics of particles raised from malt mash and are shown in Table 1. Malt used in the study was selected to provide a range of malt with particle size from 900 to 75 mm. The table shows the characteristics of the malt in terms of the size of the opening and the number of particles that pass through each opening. The data were collected and analyzed to determine the effectiveness of the manual sieving method in accurately measuring the particle size distribution of malt.
GRIST

A. BY STANDARD SIEVE TEST

This procedure is for the classification of malt grist from mill gradings by sieve analysis. The method employs a mechanical shaker for sieving a quantity of grist through standard sieves.

Apparatus
(a) Mechanical shaker device, designed for use with 8-in.-diameter standard testing sieves. See Mal-4, Standardization of Malt Sorting, Sieving ground malt for types of mechanical sorting devices available.
(b) Standard test sieve, 8-in., diameter, Nos. 10, 14, 18, 30, 60, 100, a cover, and bottom pan, or equivalent.
(c) Bowl for cleaning the sieve.
(d) Rubber balls, 1/8-in. diameter, Scre wcum 1 (Sear's, Filtration, Kansas City, MO, or equivalent).
(e) Dark paper
(f) Analytical balance, accurate to 0.1 g.
(g) Timer.

Method
Place three rubber balls on each of the U.S. standard test sieves Nos. 30, 60, and 100. Stack all sieves in order with sieve No. 10 on top and sieve No. 100 on the bottom. Place the bottom pan under sieve No. 100. Obtain a sample of ground malt for analysis and reduce it to 100 g by sifting or dividing. A “bone-type” riffle sample aliquot or divider is described in Mal-4 and is useful for dividing malt grain. Place the 100–150 g sample of malt grain on the top of sieve No. 10, cover, and mechanically stir for 5 min. Empty each individual sieve and the bottom pan onto dark paper and brush each one clean. Weigh the fractions, and record the net weight of the individual fractions to the nearest tenth of a gram.

Calculation
Calculate the percentage of malt grist retained for each fraction by dividing the weight of each fraction by the sum of the fraction weights and multiplying by 100.

\[
\% = \frac{W_f}{\sum W_f} \times 100
\]

in which:
\(W_f\) = weight of material retained for each fraction
\(\sum W_f\) = total weight of material retained

Example

\[
\begin{align*}
\%_{10} & = \frac{2.1}{10.5} \times 100 = 20.0 \\
\%_{14} & = \frac{4.1}{10.5} \times 100 = 39.6 \\
\%_{18} & = \frac{1.6}{10.5} \times 100 = 15.2 \\
\%_{30} & = \frac{0.7}{10.5} \times 100 = 6.7 \\
\%_{60} & = \frac{0.2}{10.5} \times 100 = 1.9 \\
\%_{100} & = \frac{0.1}{10.5} \times 100 = 0.9 \\
\end{align*}
\]

Precision

Based on a collaborative study (1), repeatability and reproducibility coefficients of variation ranged from 6.8 to 15.2% and 11.0 to 20.6%, respectively, because of low repeat values.

References

2001, rev 2009

B. BY MANUAL SIEVE TEST

This procedure is for the classification of malt grist from mill gradings by sieve analysis. The method employs manual shaking of U.S. standard test sieves for sieving a quantity of grist through four standard sieves.
Apparatus
(a) U.S. standard test sieves, 8-in. diameter, Nos. 10, 30, 60, 100, a cover, and bottom pan, or equivalent.
(b) Spatula, for cleaning the sieves.
(c) Rubber balls, 3/8-in. diameter, S detected.
Separation, Kansas City, MO, or equivalent.

Method
Place three rubber balls on each of the U.S. standard test sieves Nos. 30, 60, and 100. Stack all four sieves, Nos. 10, 30, 60, and 100 in order with sieve No. 10 on top and sieve No. 100 on the bottom. Place the bottom pan under sieve No. 100. Obtain a sample of ground malt for analysis and reduce it to 100–130 g by splitting or dividing. A “Jonestype” riffle sample splitter or divider is described in Malt-11 and is useful for dividing malt grist. Place the 100–130-g sample of malt grist on the top of sieve No. 10, cover, and sieve for 3 min, sliding along a smooth surface for 18 in. per 0.5 sec, and then reverse the direction (total cycle time 1.0 sec). After each 15-sec interval, tap the pan and sieve stack sharply against a flat surface (see Note 1). Empty and brush clean each individual sieve and the bottom pan onto dark-colored paper. Weigh and record the net weight of the individual fractions to the nearest 0.1 g.

The sum of all of the fractions, (g) and multiply by
\[ W_n \times 100 \]

in which:
- \( W_n \) = weight of individual fraction retained on sieve No. x (in g)
- \( W_p \) = weight of material passed through to the bottom part (in g)

\[ W_p = \text{sum of all fractions retained and passed through to the bottom pan (in g)} \]

Report the percentage of malt grist retained for each fraction to the nearest one-tenth of a percent.

References

2003, rev. 2009

Video illustrating technique for manual sieve analysis
### TABLE I

**Characteristics of Standard U.S. Sieves**

- **U.S. Sieve Microns**
  - No. 10 Husks held
  - No. 14 Husks held
  - No. 18 Husks held
  - No. 30 Coarse grits held
  - No. 60 Fine grits held
  - No. 100 Ordinary flour held
  - Pan ... ... Fine flour
Manual Method

- Individual grist samples weighing between 100 and 130 g
- 8-in.-diameter U.S. Standard test sieves nos. 10, 30, 60, 100 and a receiving pan.
- The top sieve was covered and the sieve stack was manually shaken for 3 min back and forth on a smooth flat surface.
- Traveling 18 in. (45.7 cm), and then reversing the direction in a cycle of 1 sec.
- After each 15-sec interval, the pan and sieve stack were sharply tapped.
- The individual fractions were then weighed and the weights were recorded to the nearest one-tenth of a gram.
Manual Sieve Method
How it’s done--
Grist weighed from each sieve
Homebrew Club Exercise

ZZ Hops and KC Biermeisters
Shake it!
Weighing Sieve Results
<table>
<thead>
<tr>
<th></th>
<th>Brewer A</th>
<th>%</th>
<th>Brewer B</th>
<th>%</th>
<th>Brewer C</th>
<th>%</th>
<th>Brewer D</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>49.1</td>
<td>49.1</td>
<td>30.6</td>
<td>30.6</td>
<td>48.0</td>
<td>48</td>
<td>62.5</td>
<td>62.5</td>
</tr>
<tr>
<td>30</td>
<td>40.4</td>
<td>40.4</td>
<td>54.8</td>
<td>54.8</td>
<td>47.2</td>
<td>47.2</td>
<td>33.5</td>
<td>33.5</td>
</tr>
<tr>
<td>60</td>
<td>6.1</td>
<td>6.1</td>
<td>12.5</td>
<td>12.5</td>
<td>2.3</td>
<td>2.3</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>100</td>
<td>1.1</td>
<td>1.1</td>
<td>0.6</td>
<td>0.6</td>
<td>0.3</td>
<td>0.3</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>pan</td>
<td>2.6</td>
<td>2.6</td>
<td>1.3</td>
<td>1.3</td>
<td>1.7</td>
<td>1.7</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>total</td>
<td>99.3</td>
<td>99.3</td>
<td>99.8</td>
<td>99.8</td>
<td>99.5</td>
<td>99.5</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Monster 2</th>
<th>%</th>
<th>Monster 3</th>
<th>%</th>
<th>Schmidling</th>
<th>%</th>
<th>Barley Crusher</th>
</tr>
</thead>
</table>
Compare Sieve Results with Gap Width

If your mill results are too coarse or too fine, adjust the gap between the rollers.

Check with feeler gauges.

Periodically check the gap on your mill.
# Optimizing Example

<table>
<thead>
<tr>
<th>Mill settings</th>
<th>top</th>
<th>10</th>
<th>30</th>
<th>60</th>
<th>100</th>
<th>pan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse</td>
<td>0.055</td>
<td>78</td>
<td>14</td>
<td>4</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Normal</td>
<td>0.045</td>
<td>53</td>
<td>28</td>
<td>11</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Fine</td>
<td>0.025</td>
<td>22</td>
<td>23</td>
<td>30</td>
<td>5</td>
<td>20</td>
</tr>
</tbody>
</table>
Post-sieve analysis

The method employs manual shaking of U.S. standard test sieves for sieving a quantity of grist through four standard sieves.
Malting barley methods used to measure quality

At the Grain Research Laboratory, unless otherwise specified, analytical results for barley and malt are reported on a dry weight basis. The ASBC methods cited are those of the American Society of Brewing Chemists, 8th Edition, (2008).

List of western Canadian malting barley methods and tests

- **Amylase activity**
  1. Amylase activity is determined using ASBC method MALT 7B automated to run on a Skaler segmented flow analyzer, using ASBC debranched starch as the substrate, and calibrated with standards that have been determined by method ASBC Malt 7A.

- **Glucan content**
  2. Glucan content is determined in malt extract by Skaler segmented flow analysis using Calcofluor staining of soluble, high molecular weight B-glucan (ASBC Wort 18).

- **Extractability**
  3. Extractability is determined on a Skaler segmented flow analyzer, using an automated neocuprine assay for reducing sugars, which is calibrated using malt standards analyzed using the official ferricyanide reducing sugar method, (ASBC Malt 6A).

- **Dlope and assortment**
  4. Dlope and assortment is obtained by passing an uncleaned sample through a Carter Dlope Tester arranged as described in the Canadian Grain Commission’s Official Grain Grading Guide for dlope determination. This involves passing the barley over a no. 6, no. 6c, no. 6, and no. 5 Bunkhead sieves. Material retained above the no. 5 sieve is considered to be dlope-free.

- **Assortment**
  5. All samples are passed through a Carter Dlope Tester equipped with a no. 6 dlope to remove foreign material and two slotted sieves to sort the barley. Heavy Grade barley is the material retained on a 6/34” (1.8 mm) x 3/34” slotted sieve. Intermediate Grade is barley that passes through the 3/34” sieve but not through the 6/34” sieve.

- **Ine-grind and coarse-grind Extracts**
  6. Extracts are prepared using an Industrial Equipment Corporation (IEC) mash bath and the Congress mashing procedure from 65°C to 75°C. Specific gravities are determined at 20°C with an Anton Paar DMA 5000 digital density meter (ASBC Malt 4).

- **Liquid extract analysis**
  7. Liquid extract analysis is determined on the rice extract according to the official ASBC method Wourt-32, automated to run on a Skaler segmented flow analyzer.

- **Vitamin content**
  8. Vitamin content is determined by placing 150 kernels of barley on two layers of Whatman No. 1 filter paper, in a 9.0 cm diameter petri dish, and adding 4.0 ml of purified water. Samples are controlled at 20 degrees Celsius and 90% relative humidity in a germination chamber. Germinated kernels are removed after 24 and 48 hours and a final count is made at 72 hours (ASBC Barley 3C, D1B, and EBC procedures).

- **Pach index (Ratio R/T)**
  9. Pach index is calculated from the formula, (% Soluble protein/ % Malt protein) x 100.

- **Proximal analysis**
  10. Proximal analysis is performed using an Automatic Phoenix Micromill System designed to handle twenty-four 500 g samples of barley per hour.
How will these differ in a “Congress Wort”? 

Barley Malt Quality Methods 

Also need to consider that many standard methods are old! 

- **Extract** (Congress Mash), origins are in late 1800’s 
  - Original intent was only to determine maximum theoretical extract. 
  - However, Congress wort is now used for all standard wort analyses. 
    - Non-ideal mash conditions. 
- Origins of ASBC alpha-amylase and DP methods is prior to 1920
Congress Mash

- Named for the standardized process instituted by the European Brewing Congress (EBC) in 1875.
- A standard weight of finely ground malt is multi-infusion mashed over a period of nearly 2 hours.
- The mash is filtered thru a paper filter for a period of 1 hour and the specific gravity is measured. The % Extract, Fine Grind, As-Is is calculated from the ASBC Table for Extract Determination in Malt.
Kitchen Congress Wort, using an induction hotplate

100 grams of milled malt — Sample B on left
Sample D on right

300 mL strike water at 120F; held for 60 minutes (stirring every 15 minutes)

Temperature increased to 160F over 60 minutes (stirring every 15 minutes)

At the end of 2 hours, samples filtered through coffee filters

Specific Gravity checks
Finer vs Coarser

Coarser grind exposes less of the endosperm—

Less contact with heated water—

Less enzyme activation—

Less conversion to sugar

<table>
<thead>
<tr>
<th>Sieve 30</th>
<th>Sieve 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>54.8 %</td>
<td>33.5 %</td>
</tr>
<tr>
<td>1.072 SG</td>
<td>1.065 SG</td>
</tr>
</tbody>
</table>
Sieves are something a good homebrew supply shop should have!

Not only to check customers’ mills, but their own!
When malt is a major part of a recipe, the coarseness of the grind is important.

Proper grind is important not only to all-grain brewing, but also to partial-mash brewing.
Summary

- Milling consistently is important in making consistent beers
- Optimizing mill settings is beneficial in achieving efficient extraction of sugars and avoiding stuck mashes
Efficient extraction from proper mill settings saves on malt bill and makeup additions of DME to achieve desired target Original Gravity

Adjustable mills should be periodically checked; gap setting can be measured with feeler gauges—and compared with sieve results

Summary
References

- Schwarz, P., Barr, J., Joyce, M., Power, J. and Horsley, R.
- Methods of Analysis, Malt-15, American Society of Brewing Chemists, 2009
- Practical Milling for the Craft Brewer, Briess presentation for the Craft Brewers’ Conference, Bob Hansen, 2007
THANKS, AND COME SEE!