New (Research) Methods for Barley Malt Quality Analysis

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Barley Malt Quality Methods

• A frequent criticism is that “Official methods often do not address or accurately predict brewhouse performance”. Examples:
  – Homogeneity of the sample
  – Filterability
  – Flavor
  – Flavor stability
  – Colloidal stability
  – Fermentability
  – PYF
  – Others?

• Research and new methodology is required
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

Windisch, 1895
New Methods for Barley Malt Quality Analyses

• Adaptation of New methods to official status often is slow
  – Test must be of interest to an adequate number of laboratories for collaborative testing to take place
  – Expense of required equipment
  – Wide variations in brewer’s processing and products complicates standardization of many new methods.

  • Very specific process or product related tests may have limited applicability
Filterability/Lautering Performance

Research Methods
• Tepral Filtration, 1989
• VTT Buchner Filtration test, 1994
  – Better correlation with brewhouse performance
  – Methods require alternative lab mash procedures
    • Have not been widely adopted?
Flavor Stability

Methods

• LOX (lipoxygenase) (high throughput assay of Li)
  – Proprietary issues in breeding
  – LOX is not the whole story

• ESR (electron spin resonance)
  – ASBC has evaluated ESR(EPR) for beer oxidation
    • Applicability to malt?
Malt Enzymes

• Origins of Official methods for alpha-amylase and diastatic power were over 100 years ago!
  – Not simple, and have proven difficult to automate
  – Not direct assays in kinetic terms

• Newer methods using synthetic substrates (e.g. MegaZyme) can provide much more reliable and direct data
  – Alpha-amylase, beta-amylase, limit-dextrinase.
  – Partial automation with plate reader (Evans 2005)
  – Incorporation of other enzymes (beta-glucanase) is possible
Fermentability

• Rapid fermentation of Congress Wort
  – Poor discriminative power
    • 70 C saccharification rest lowers maltose levels
    • Dilute (8% P) mash and no adjunct means all factors (enzymes, FAN, etc) are likely in excess
    • Varying yeast amount (g) can slightly improve results

• Rapid fermentation of modified mash
  – Use of adjunct and thicker (alternative) mash
    • Better discriminative power (factors are limiting)
  – Modified mash is very brewer/product specific
    – Unlikely to be widely adopted?
Fermentability

• **Predictive.** E. Evans (2005, 2008) has shown that AAL can be accurately predicted ($r^2=0.91$) by measuring:
  - Alpha-amylase (a)
  - Limit-dextrinase (b)
  - Kolbach index (c)
  - Beta-amylase (d)
  - Beta-amylase thermostability (e)

\[ AAL = 69.9 + 0.017(a) + 0.010(b) + 0.195(c) + 0.007(d) + 0.538(e) - 0.001 \cdot (d)(e) \]
Cell Wall Polysaccharides

• Beta-glucan
  • ASBC wort-18, EBC 3.10.2
  • Calcofluor-FIA
  • MW range measured depends on ionic strength of eluant.
    • Are we measuring the right range?
  • Is concentration sufficient or do we need MW data too?
  • Are we using the right standard?

• Arabinoxylans
  • Are they the culprit when “low beta-glucan” malts give lautering or filtration problems?
  • Should we be looking at these too?
Conclusions

• Existing Official methods are essential as a basis of trade and for routine quality assurance
  – However, they do not provide the “complete picture”
  – Research and development of new methodology is essential

• Adoption of methods that predict performance is hampered by wide variations in brewer formulation, equipment and processing
  – Universal methods?

• Adoption of methods for constituents/contaminants (DON, sprout damage, etc) is likely to be quicker
Conclusions

ASBC Malt-4 (Extract) is an issue (and has been for 100 years!)

• Method was never intended to duplicate the brewhouse, nor provide wort for analysis.
• However, the method is ingrained, and change is unlikely
  – A suitable replacement method that will satisfy the needs of all maltsters and brewers seems unlikely
• **Breeding programs could benefit from change in method**
  – Use of coarse grind in Congress mash, or an alternative mash procedures (Hot Water Extract) will provide better discriminative power
Conclusions

Methods for Alpha-amylase and Diastatic Power are also an issue

• Alpha-Amylase Malt-6 is an indirect assay based upon a change in substrate property
  – It is not free from interference from beta-amylose
  – (Official) Manual method is no longer used
  – Automated method has been extremely difficult to standardize

• Diastatic Power Malt -7 is not a direct measure of beta-amylose
  – Instances of high DP and poor conversion

• Direct measure of individual enzymes would provide more reliable data and possibly an estimate of fermentability