A review of malting barley development in Canada

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Evolution of a quality testing program for improving malting barley in Canada
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Outline for the presentation

- Early barley assessment - OAC 21
- Laboratory malting - Olli
- Comparative testing and check cultivars - Montcalm, Parkland
- Expansion of malt analysis - Bonanza
- Refining malt analysis - Harrington, AC Metcalfe, CDC Copeland
- Future directions for quality evaluation
Early history of malting barley in Canada

- English landraces: Thorpe and Chevrier
- Quality evaluated with simple sensory tests
OAC 21: The first true selection in Canada

- Selected as a single plant from Manchurina in 1890’s (Guelph, Ontario)
- Selection based on lodging and yield
- OAC 21 most widely grown across the country
- Domestic malting industry identified OAC 21 as western Canada’s cultivar with the greatest malting potential (1920)
## History of CGC’s standard malting cultivars

<table>
<thead>
<tr>
<th>Two-rowed barley</th>
<th>Six-rowed barley</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year</strong></td>
<td><strong>Variety</strong></td>
</tr>
<tr>
<td>1930</td>
<td>Thorpe</td>
</tr>
<tr>
<td>1971</td>
<td>Betzes</td>
</tr>
<tr>
<td>1985</td>
<td>Klages</td>
</tr>
<tr>
<td>1993</td>
<td>Harrington</td>
</tr>
</tbody>
</table>

*Standard variety replaced by eligibility list in 2004*
Early comparative testing (compared to OAC 21)

- Malting began in 1929 at the University of Manitoba
- All the samples malted under the same schedule
- Malt extract and diastatic power (DP) only things measured reliably and understood
- Led to release of Olli, a Finnish import (1930’s) with acceptable levels of extract and high levels of DP
Evolution of micro-malting (NRC 1940’s)

- Better controlled airflow to prevent drying out of the barley
Montcalm 1945

- First malting barley cultivar from a hybrid cross made in Canada
- Compared to OAC 21
  - slightly higher malt extract
  - similar level diastatic power
  - similar steeping times and malt losses

<table>
<thead>
<tr>
<th></th>
<th>OAC 21</th>
<th>Montcalm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain protein</td>
<td>14.4</td>
<td>13.6</td>
</tr>
<tr>
<td>Malt extract</td>
<td>75.4</td>
<td>76.4</td>
</tr>
<tr>
<td>DP (° Lintner)</td>
<td>122</td>
<td>129</td>
</tr>
</tbody>
</table>

Data Source: Western Canadian Coop Trials 1940-1945
Parkland 1956

- First cultivar bred in Canada with quality evaluation throughout development
- Compared to OAC 21
  - similar level of diastatic power
  - lower grain protein and higher malt extract

<table>
<thead>
<tr>
<th></th>
<th>OAC 21</th>
<th>Parkland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain protein (% DM)</td>
<td>15.1</td>
<td>14.4</td>
</tr>
<tr>
<td>Malt extract (% DM)</td>
<td>73.1</td>
<td>74.7</td>
</tr>
<tr>
<td>DP (° Lintner)</td>
<td>154</td>
<td>151</td>
</tr>
</tbody>
</table>

Data Source: Western Canadian Coop Trials 1951-1956
Refining malt analysis:
Dawning of the Age of Gums (1950’s)

- Bass, Meredith & Anderson 1952
  Enzymes that degrade barley gums
  I Isolation from a bacterial source
  Cereal Chem. 29:262-272

- Fine-coarse malt extract difference

- Wort viscosity

- Kolbach index
  - now used specifically for protein modification
Timelines for methods used to evaluate malt quality of barley cultivars for western Canada
Pilot-scale malting and brewing (1950’s)

- Malting done by industry as well as GRL
- Brewing done by BMBRI and industry
Bonanza 1970

- Last commercially successful blue-aleuroned, six-rowed malting barley
- Low grain protein and high extract combined with high levels of DP and alpha-amylase
- Faster processing

<table>
<thead>
<tr>
<th></th>
<th>Conquest</th>
<th>Bonanza</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain protein (% DM)</td>
<td>15.2</td>
<td>14.3</td>
</tr>
<tr>
<td>Malt extract (% DM)</td>
<td>76.2</td>
<td>77.3</td>
</tr>
<tr>
<td>Fine/coarse difference</td>
<td>2.8</td>
<td>2.9</td>
</tr>
<tr>
<td>DP (° Lintner)</td>
<td>172</td>
<td>170</td>
</tr>
<tr>
<td>α-Amylase (DU)</td>
<td>25.2</td>
<td>22.5</td>
</tr>
</tbody>
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Data Source: Western Canadian Coop Trials 1967-1968
Six-rowed, white-aleuroned malting barley

- B1602, Robust, Excel, Legacy
- High levels of diastatic power and α-amylase
- Combined with high levels of soluble protein

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<thead>
<tr>
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<th>Bonanza</th>
<th>B1602</th>
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<tbody>
<tr>
<td>Malt extract (% DM)</td>
<td>76.1</td>
<td>77.7</td>
</tr>
<tr>
<td>Kolbach Index (%)</td>
<td>39.2</td>
<td>42.8</td>
</tr>
<tr>
<td>DP (° Lintner)</td>
<td>206</td>
<td>212</td>
</tr>
</tbody>
</table>

Data Source: Western Canadian Coop Trials 1986-1988
Sixty years of Canadian malting barley cultivars

Data Source: Line Elevator Association & Canadian Wheat Board variety surveys
Developing world class two-rowed malting barley for Canada

Canadian malting industry said (1960):

“If Canada is to become a consistent supplier of malting barley and barley malt on world markets, we must develop two-rowed barley cultivars that can produce good quality malt…….”

“……..quality to include high levels of malt extract combined with high levels of starch-degrading enzymes and an ability to process quickly.”
Three significant steps in developing two-rowed malting cultivars for the prairies

Betzes ➔ Klages ➔ Harrington

- Polish cultivar imported via US (1960)
- Quality approaching six-rows
- Early maturity
- Grown in dry land areas

- American-bred cultivar
- Two-rowed acres increased with better quality and agronomic traits (1970)
Harrington 1982

- Low protein cultivar with good extract and modification
- Also had high levels of starch-degrading enzymes

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<td>Grain protein (% DM)</td>
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<td>13.6</td>
<td>12.9</td>
</tr>
<tr>
<td>Malt extract (% DM)</td>
<td>75.8</td>
<td>79.0</td>
<td>79.8</td>
</tr>
<tr>
<td>Fine coarse difference</td>
<td>12.6</td>
<td>8.5</td>
<td>7.3</td>
</tr>
<tr>
<td>DP (° Lintner)</td>
<td>83</td>
<td>99</td>
<td>119</td>
</tr>
<tr>
<td>α-Amylase (DU)</td>
<td>24.7</td>
<td>42.6</td>
<td>47.5</td>
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Data Source: Western Canadian Coop Trials 1978
Beginnings of the automated systems

- First automated system designed and built at the Cereal Breeding Laboratory, Winnipeg (1960’s and 70’s)
Invasion of the Australians: Modern, automated (lab-scale) maltings

Phoenix Micromaltungs
- Endosperm modification more consistent and reproducible
- Improved ability to measure endosperm modification (wort β-glucan and friability)

Joe White Maltings
New technology and changing quality specifications

- Mash filters
- Processing more affected by β-glucan

Microfiltration of beer
Balance modification

Data source: CGC harvest survey quality bulletins
### AC Metcalfe 1994 / CDC Copeland 1999

- **AC Metcalfe**: Good enzyme potential combined with high extract and balanced modification
- **CDC Copeland**: Good level of friability

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<th>CDC Copeland</th>
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<tr>
<td>Malt extract (% DM)</td>
<td>79.5</td>
<td>79.9</td>
<td>79.5</td>
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<tr>
<td>Kolbach Index (%)</td>
<td>39.4</td>
<td>39.2</td>
<td>39.5</td>
</tr>
<tr>
<td>Wort β-glucan (mg/L)</td>
<td>162</td>
<td>96</td>
<td>76</td>
</tr>
<tr>
<td>Friability (%)</td>
<td>82</td>
<td>77</td>
<td>84</td>
</tr>
<tr>
<td>DP (° Lintner)</td>
<td>125</td>
<td>145</td>
<td>125</td>
</tr>
<tr>
<td>α-Amylase (DU)</td>
<td>54.4</td>
<td>62.2</td>
<td>48.4</td>
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*Data Source: CGC Malting Barley Harvest Survey 2004-2009*
The changing of analyses used for registering malting barley cultivars
The Future

- Does knowledge of individual starch-degrading enzymes provide more information?
The Harrington advantage: Limit dextrinase

Data Source: CGC Malting Barley Harvest Survey 2004-2009
The Future

- Does knowledge of individual starch-degrading enzymes provide more information?
- Homogeneity of kernel size versus percent plump
Advantages of measuring homogeneity of barley size versus kernel plumpness

<table>
<thead>
<tr>
<th>seed diameter</th>
<th>number of kernels</th>
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<tbody>
<tr>
<td>&gt;7/64</td>
<td>&gt;6/64</td>
</tr>
<tr>
<td>65%</td>
<td>95%</td>
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<tbody>
<tr>
<td>&gt;7/64</td>
<td>&gt;6/64</td>
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<tr>
<td>80%</td>
<td>95%</td>
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The Future

- Does knowledge of individual starch-degrading enzymes provide more information?
- Homogeneity of kernel size versus percent plump
- Beer flavour: Importance of individual amino acids versus FAN
UPLC and amino acid analysis

Chromatogram: derivitized wort

Waters UPLC system
– C18 reversed phase column
The Future

- Does knowledge of individual starch-degrading enzymes provide more information?
- Homogeneity of kernel size versus percent plump
- Beer flavour: Importance of individual amino acids vs FAN
- Markers for specific traits like: low lipoxygenase and low phytate barleys
Acknowledgements

- All the cooperators in the Western Canadian Barley Cooperative tests
- Maltsters: Jim Bethune, John Walkof, Shawn Parsons
- Malt analysis: Maureen Stethem, Carol Carmichael, Aaron MacLeod, Debby Shaluk
- Chemists: Dennis Langrell, Aaron MacLeod