Falling Number®
Serving the Grain & Flour Industry for More Than 50 years

Martin Hallin
Perten Instruments AB, Stockholm, Sweden
AACC meeting April 1963

- Presentation of the Falling Number method by Mr Harald Perten:

  “Millers and bakers are greatly interested in reliable methods for the determination of the amylase activity in flour, in order that the amylase might be adjusted to a desired level.”
What are we striving at?

- Helping the industry avoid this!
What are we striving at?

• And instead produce this!
• Harald Perten - a baker’s son and cereal chemist originating from Estonia.
• Worked in the 1950’s in the Cereal Laboratory of Swedish Institute for the Crafts and Industries with Sven Hagberg.

Harald Perten in seminar
• The task:
  Find a practical mean to detect alpha-amylose in grain and flour.
• The result:
  Falling Number method.
The Falling Number method

- Resemblance to bread baking.

Fermentation: Yeast + Glucose → CO₂

\[ \text{Starch molecule} \xrightarrow{\alpha\text{-amylase}} \text{Maltose} \xrightarrow{\text{maltase}} \text{Glucose} \]
The Falling Number method

- Resemblance to bread baking:

  "In the Falling Number method it takes about 30 seconds to pass the critical temperature range for amylase activity from starch gelatinization at ~55 °C to heat inactivation of the enzymes at ~80 °C. In bread crumb during baking (in 250 °C) it takes about 40 seconds."
The Falling Number method

- Procedure
  - Grind (300 g)
  - Weigh (7.00 g)
  - Dispense (25.0 mL)
  - Disperse
  - Place tube + stirrer in instrument
    - Mix (60 s)
    - Measure (time varies)
The Falling Number method

- Applicable to whole meal and flour of Wheat, Durum wheat, Rye and Barley, but also to related grain types like Triticale, Sorghum, Spelt wheat etc.
The Falling Number results

- Result
  - Falling Number = time to in seconds mix & allow stirrer to fall through cooked slurry
  - Corrections for sample moisture content and altitude (bath temp)
  - Premium > 350 s, Sound 200 – 300 s, Sprouted < 150 s
• 1961 first Falling Number® instruments sold (in Ireland).

• 1962 the company "Falling Number AB" formally founded.

A COMPLETE FALLING NUMBER EQUIPMENT CONSISTS OF:
FALLING NUMBER APPARATUS, FALLING NUMBER MILL,
TUBE CLEANER, AUTOMATIC PIPETTE

Wheat quality is a decisive factor influencing the baking property of a flour.
A mere 5½% of sprouted grain can make 95% of perfect grain useless for the manufacture of bread.
For instance, if there is too much alpha-amylase activity in the flour, it will result in a sticky bread crumb.
Continuous control of the alpha-amylase activity is essential in the grain trade, flour mills and bakeries.
The Falling Number method by Haugaard-Perten is the quickest, cheapest and most reliable method for the determination of the alpha-amylase activity and hence the extent of sprout damage.
The Falling Number Method also enables a grist with the best baking properties to be formulated from the wheats available.
The Falling Number Apparatus utilises the principle of the rapid gelatinization of a flour suspension with subsequent measurement of the liquefaction of the starch through alpha-amylase enzyme activity, simulating the changes which occur during the baking process.

FALLING NUMBER APPARATUS, Type ST
for the determination of alpha-amylase activity
(Perlen-System)

The illustrations shows a standard Falling Number Apparatus for manual operation with automatic timer.
Dimensions:
20" x 11" x 14" (500 x 280 x 350 mm)
Weight: Nett 22 lbs. (10 kg)
Standardisation = Communication

- 1968: ICC Standard No. 107/1
- ”Determination of the” Falling Number” according to Hagberg – Perten as a Measure of the Degree of Alpha-Amylase Activity in Grain and Flour”
Standardisation = Communication

- AACC International 56-81.03
- ISO 3093:2009
- And many national standards followed as well.

**Perten Falling Number® instruments**
The only validated instruments for the Approved Methods.
Falling Number – a World user standard

- Optimization of alpha-amylase activity in flour.
Falling Number – a World user standard

• Segregation and classification of wheat and rye.
Falling Number – a World user standard

- Guarantee soundness of traded grain.

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2014</th>
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<tbody>
<tr>
<td></td>
<td>No.1</td>
<td>No.2</td>
</tr>
<tr>
<td><strong>Wheat</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test Weight, kg/hl</td>
<td>81.9</td>
<td>81.2</td>
</tr>
<tr>
<td>Weight Per 1000 Kernels, g</td>
<td>42.4</td>
<td>44.2</td>
</tr>
<tr>
<td>Vitreous Kernels, %</td>
<td>95</td>
<td>81</td>
</tr>
<tr>
<td>Protein Content, %</td>
<td>13.8</td>
<td>13.7</td>
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<tr>
<td><strong>Ash Content, %</strong></td>
<td><strong>1.52</strong></td>
<td><strong>1.55</strong></td>
</tr>
<tr>
<td><strong>Falling Number, sec</strong></td>
<td><strong>420</strong></td>
<td><strong>380</strong></td>
</tr>
</tbody>
</table>
Falling Number – a World user standard

- Optimization of harvest time.

Enzymatic activity

Maturing

Sprouting
Falling Number – a World user standard

• ...and breeding.
Technical development

- From manual to semi-automatic to automatic method with improved instruments.
Technical development

• Modernisation since 1960’s but with remaining methodology for the test.
Technical development

• Features

• Automatic water level control
• Automatic MAX time
• Automatic altitude correction
• Data logging and export
• External communication
• Mix and malt addition calculations
• and more
Technical development

- Supporting accessories
  - **Spolett** for easy cleaning of the tubes
  - **Cooling Tower** for minimized cooling water consumption.
  - **Shakematic** for operator ease and improved repeatability
  - **Lab Grinder** for appropriate sample preparation
Fungal Falling Number method

- Complementary method for detection of fungal alpha-amylase enzymes.
- Verify addition of fungal enzymes.
- Control total enzymatic activity in unknown flour samples.
- 90°C, buffer solution and starch substrate.
- Available in certain Falling Number models.
Application development – Fast FN prediction

• 1997 FN+ prototype developed by Perten (Bo Allvin)
  • Force sensing in mixing claws & bath temperature control
  • Analysis of starch pasting properties
  • Not released (Perten later acquired the Newport RVA)

• Target - Improve grain elevator throughput
  • Where rain has occurred samples will be tested for FN value
  • Usually many or most samples are found to be sound (FN > 250)
  • Prediction option will save 3 – 5 minutes per test for these samples
  • Allowing more rapid turn-around to get trucks back to the growers’ fields
Fast FN prediction - Force data

- Force sensors
  - Type and placement
- Stirring cycle
  - 110 cycles @ 2/sec from 5 to 60 sec
  - Compression stroke
  - Data acquisition
- Data structure
  - Micro (2 Hz)
  - Macro (60 s)
- Signal processing
  - Trigger
  - Per cycle – average force
Fast Falling Number prediction

• Primary application
  • Predict the FN value for a sample
  • During the test, in the first minute of mixing
  • Stop the test if the predicted value is safely above the sound grain threshold
  • Continue the test if the FN value is predicted to fall in the critical grading range

• Method precision is comparable to the standard FN test
Alternative methods?

- 1980’s in Australia, interest for method without need for cooling water, and possibly faster.
- The Rapid Visco Analyser (RVA).
- The Stirring Number method – weather damage suite.
- RVA – Starch characterization and Ingredient performance

- Falling Number and NIR?

Karl Norris, retired, USDA Beltsville, personal communication
Company development

- Falling Number AB ➔ Perten Instruments Group 1986
- Part of the PerkinElmer company since 2014

- Wide range of products for the Grain, Flour, Feed and Food industries.
Falling Number® - Summary

- Falling Number is still the World User Standard
  - Sprout Damage detection
  - Segregation and Classification of Wheat & Durum wheat
  - Optimization of Alpha-amylase activity in Flour
- Development is ongoing
  - Fast prediction and Standard method during the same test

Perten Falling Number® instruments
The only validated instruments for the Approved Methods.
Thank you!