Functional Analyzers for Grain, Flour and other Food applications

Martin Hallin, Perten Instruments AB, Sweden

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Complete Analysis

Functional Properties

Gluten determination, testing functional properties of protein

Flour & Dough testing – hydration, stickiness, elasticity, etc.

Enzyme activity, Starch pasting

Texture, mouth-feel

Hardness

Volume

Composition

Moisture
Ash
Protein
Starch
Fiber
Sugars
Oil/Fat

Complete analysis of flour means knowing both:

What's in the flour (composition)

How will the flour perform its required duties (functional)

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Perten Analyzers

Compositional

DA 7250
NIR

DA 7300
In-line NIR

AM 5200
Grain Moisture Meter

IM 9500
NIR Grain Analyzer

IM 8800
Portable NIR Grain

Functional

doughLAB/mdL

Falling Number®

Glutomatic

RVA

Texture Analyzers

Volume Analyzers

SKCS

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1. **Rain** at harvest can cause grain to sprout
2. **Sprouting** increases alpha-amylase

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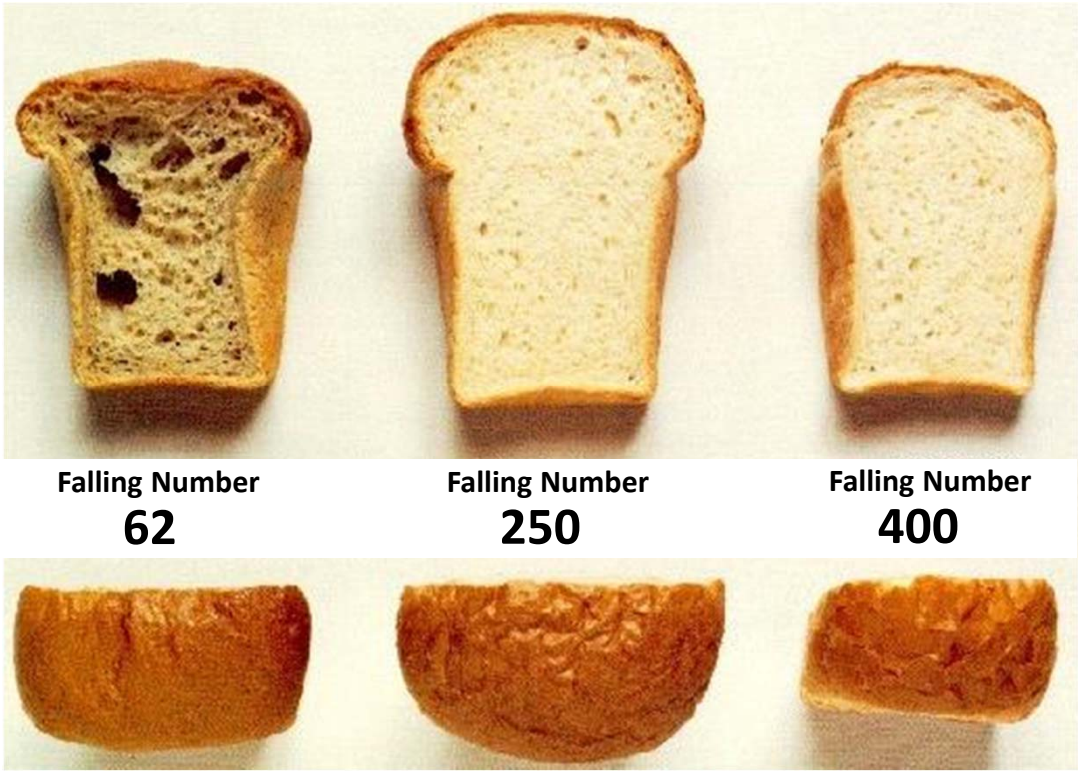
3. **Alpha-amylase** breaks down starch during baking

4. **Falling Number®** is the world standard method for detection



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Falling Number® World Standards

Only Perten Falling Number® instrument models follow all international standards.

AACCI 56-81.03

ISO/DIS 3093

ICC 107/1

EEC 689/92

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Effect of blending wheat or flour

FN 255	FN 100	FN 255	FN 100

→

FN 130

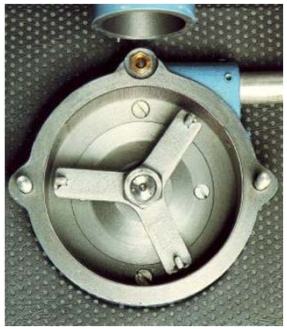
When mixing wheat/flour with different FN values, the FN value of the mix will be lower than the average of the original batches.

Capture the value of high FN wheat – segregate at intake

The Falling Number Test

Whole wheat grain

Wheat flour



Laboratory Mill
3100 or 120

Falling Number

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The Falling Number® Models

NEW!

Falling Number® 1000
Dual analysis model with many automated features

Falling Number® 1500
Automatic single analysis system

Falling Number® 1310
Value priced single analysis model

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Falling Number® 1000

Faster, Safer and Easier to use

- And also
  - More accurate
  - Versatile
  - Better connected
  - Full range of accessories
  - Approved & trusted

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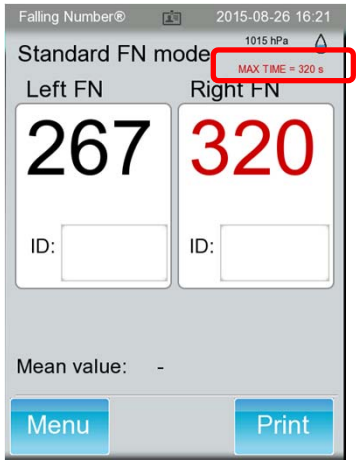
Falling Number® 1000

- Faster
  - **Set a stop time for the test**
    At high sample load times, like during the harvest, set your target maximum FN test time. When reached the instrument will stop automatically, push down the stirrers and report the results, e.g. ”320” in red.
  - **Automatic water level control**
    A built in pump keeps the water bath at optimum fill level allowing the instrument to be operational immediately.



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Falling Number® 1000

- Safer
  - **Isolated water bath and lid**
    FN 1000 is designed with an isolated water bath and a cooling lid with a plastic outer part, protecting operators from hot surfaces
  - **Reduced steam**
    Briefly turns off the bath heaters at the end of the test letting operators remove casette under reduced steam
  - **Water bath auto refill**
    No need for the operator to open the steam flaps to top up water in the bath

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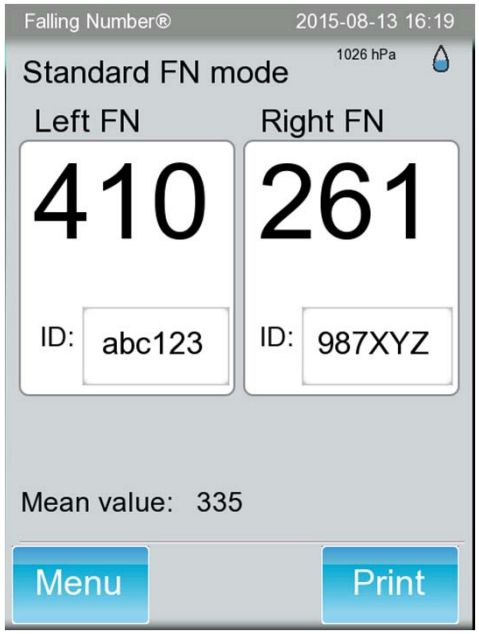
Falling Number® 1000

- Easier to use
  - **Touch screen**
    Easy user interface for the operator
    Tilt adjustable
  - **Atmospheric pressure measurement**
    Alerts user to apply altitude correction
  - **Auto-start & stop**
    Test starts automatically
    Auto-stop at user set time
  - **Results averaging and storage**
    Left & Right FN results averaging
    USB & ethernet ports for printer and LIMS connectivity
    Old results stored in instrument



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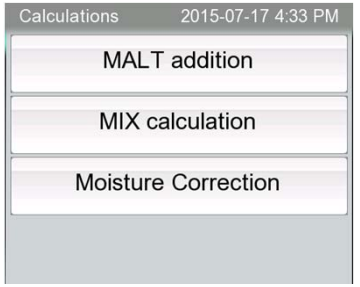
Falling Number® 1000

- Versatile and Better connected
  - **All applications**
    Standard FN testing of grain and flour
    Blending and Malt addition
    Moisture correction of sample weight or results
    Fungal amylase method
  - **Multi connectivity**
    4 USB ports and 1 Ethernet port enables simultaneous use of printers, bar code readers, data capture connetion and more
  - **Data security**
    Review results for past results from the database
    Results include traceability information



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Falling Number® accessories

Shakematic

Recirculation cooler

Automatic dispenser

Spolett tube cleaner

Printer

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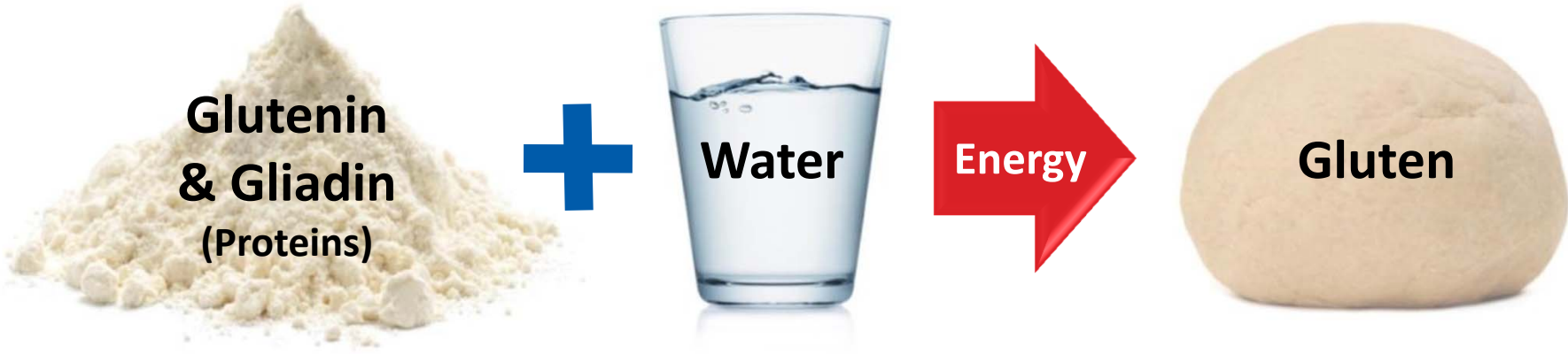
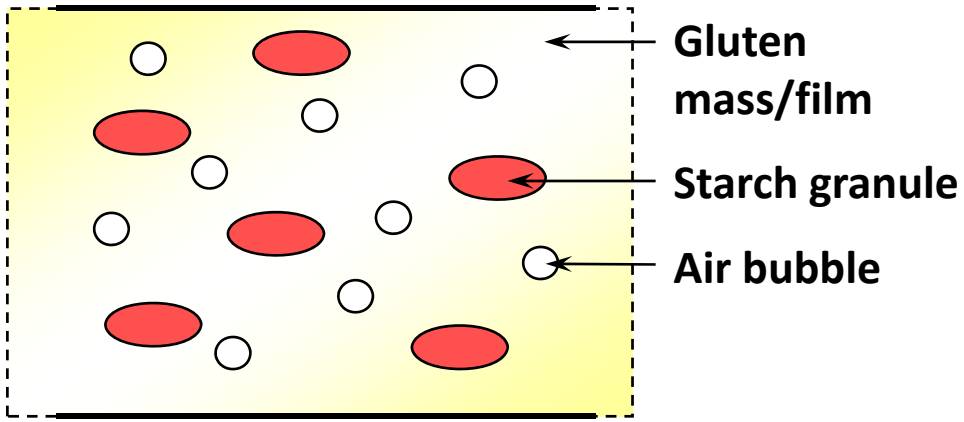
Glutomatic - Protein functionality



- Form an elastic dough
- Gas retention during fermentation and baking
- Allows and carrys expansion
- Retain form of bread loaf



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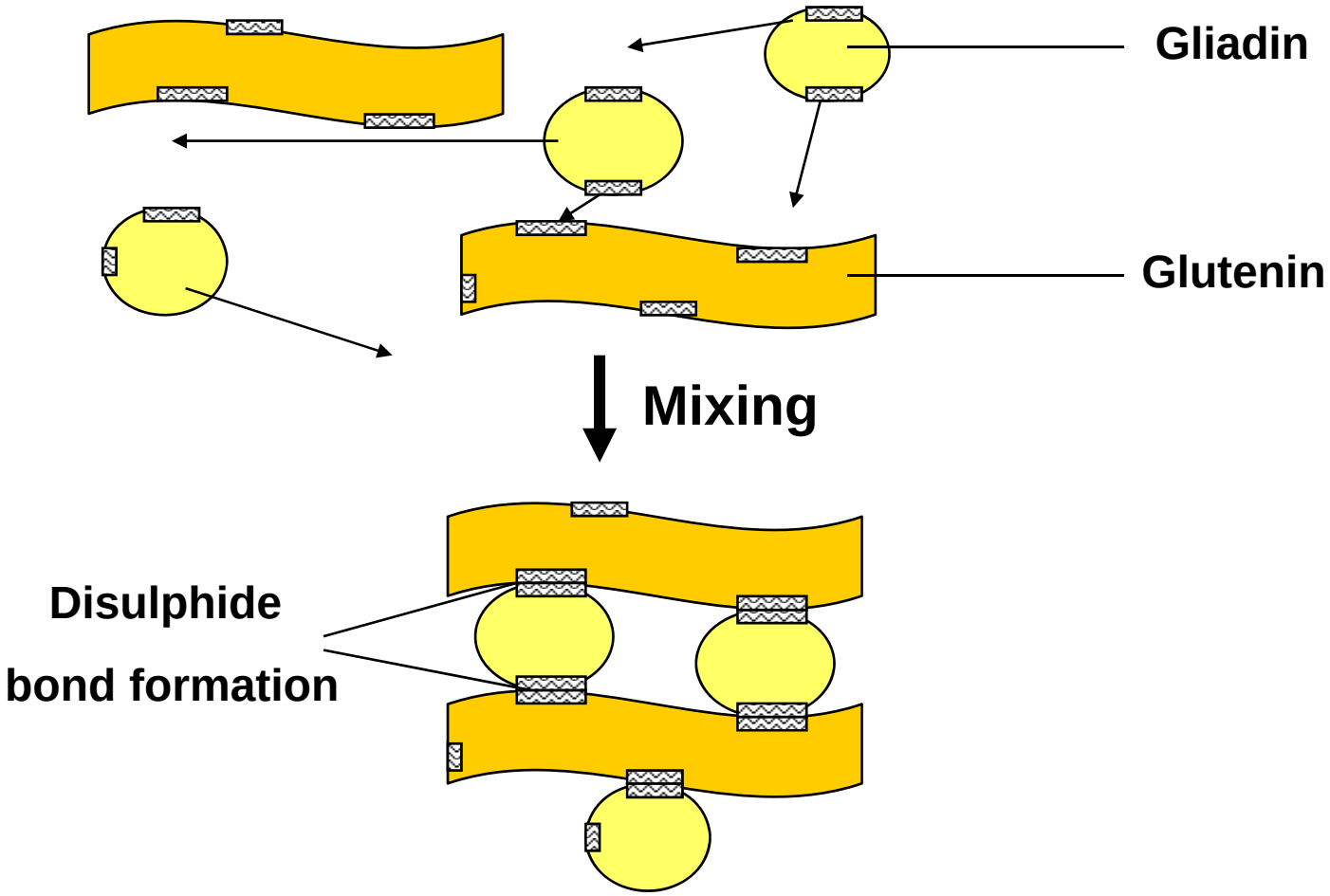
Tentative model of the gluten matrix



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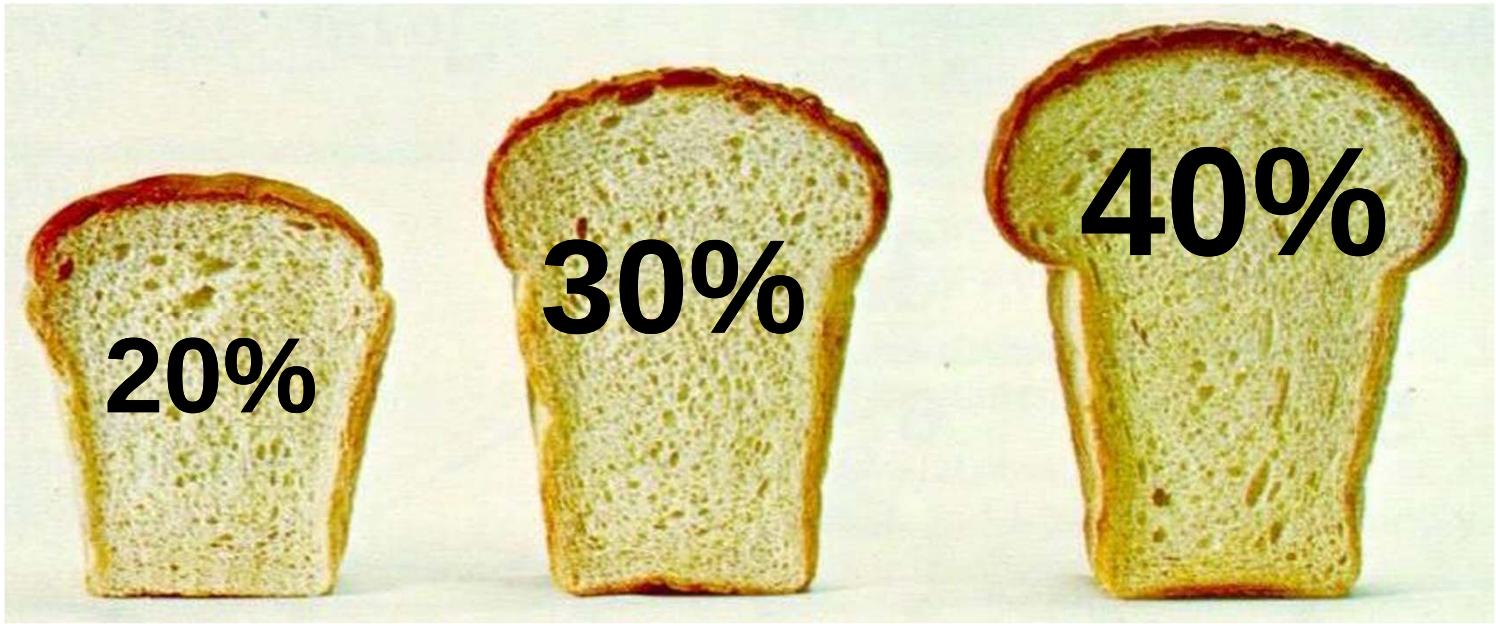
Effect of Gluten quantity

- Gluten quantity and quality influence product quality
- Different products require different gluten levels
- Glutomatic is objective and reproducible
- Internationally standardized



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Gluten Strength & Durum Quality

Gluten Index a standard for Durum quality

- Gluten strength affects
  - pasta texture - “al dente” bite
  - cooking quality - cooking residue
  - cracking or stretching of strands during drying

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Glutomatic world standards

International standard methods
for gluten content and Gluten Index:

ICC 137/1	Approved 1982, revised 1994
ICC 155	Approved 1994 (revised 2001)
ICC 158	Approved 1995
AACCI 38-12.02	Approved 1995, revised 2001
ISO 21415-2/4	Approved 1990
GAFTA 34:2	

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Glutomatic method

Laboratory mill
LM 3100 or
LM 120

Glutomatic system

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The Glutomatic System

Glutomatic 2200
and Centrifuge 2015
For Wet Gluten Content
and Gluten Index.

Glutork 2020
For Dry Gluten Content.

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Sample Preparation

Two types of Laboratory Mills from Perten:

- For fine, homogeneous grind:
  Hammer mill with sieve.
  LM 3100 & LM 120

- For milling without moisture loss:
  Disc mill.
  LM 3310 & LM 3610

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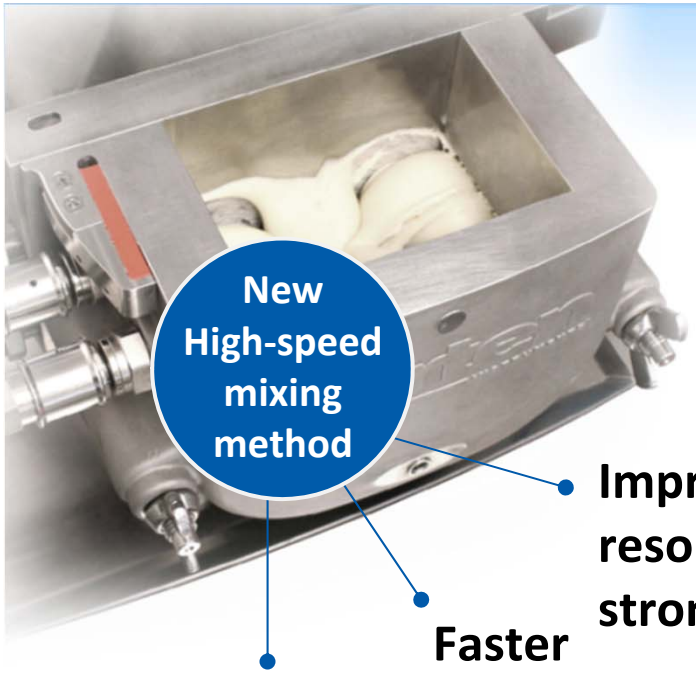
doughLAB – flour testing



Improved peak resolution in strong doughs

Faster

Better emulates modern commercial dough mixers

Determine flour properties:

Water absorption, Dough Development Time and more

10min

Standard Flour Rheological Measurements

AACCI and BIPEA check sample services for flour water absorption, dough development time & others, following AACCI method 54-21.02

doughLAB has participated since September of **2007**

The Perten doughLAB has never been an outlier within the population of instrumentation

Majority of the instruments tested are Farinographs

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Shortfalls of AACCI 54-21.02 method

Slow

Not process relevant

Produces misleading results

Slow

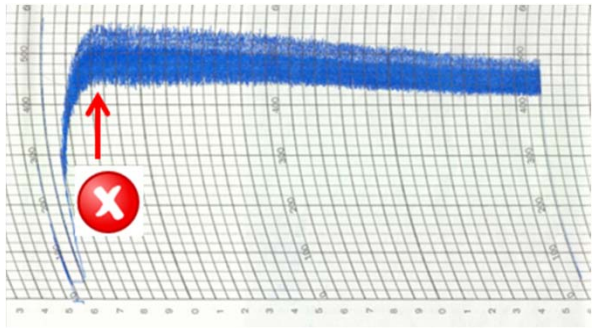
1 – 2 samples / hour

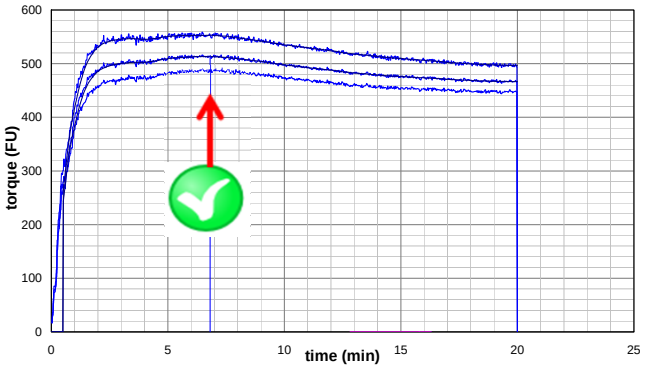
Not process relevant

63 rpm = 1 watt.hr/kg, 20 min mix

Modern mixers = 2 – 4 watt.hr/kg, 2 – 5 min mix

Poor correlation to baking requirements





Produces misleading results

Wrong peak detected for strong flours and reduction flour streams used in breadmaking

Misleads bakers on water addition and mixing time

Lower bread quality and loss of production

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New and improved AACCI method

Correct information

Resolves and detects the true dough development peak

Gives the baker the correct water addition and mix time information

Twice as fast

10 minute test

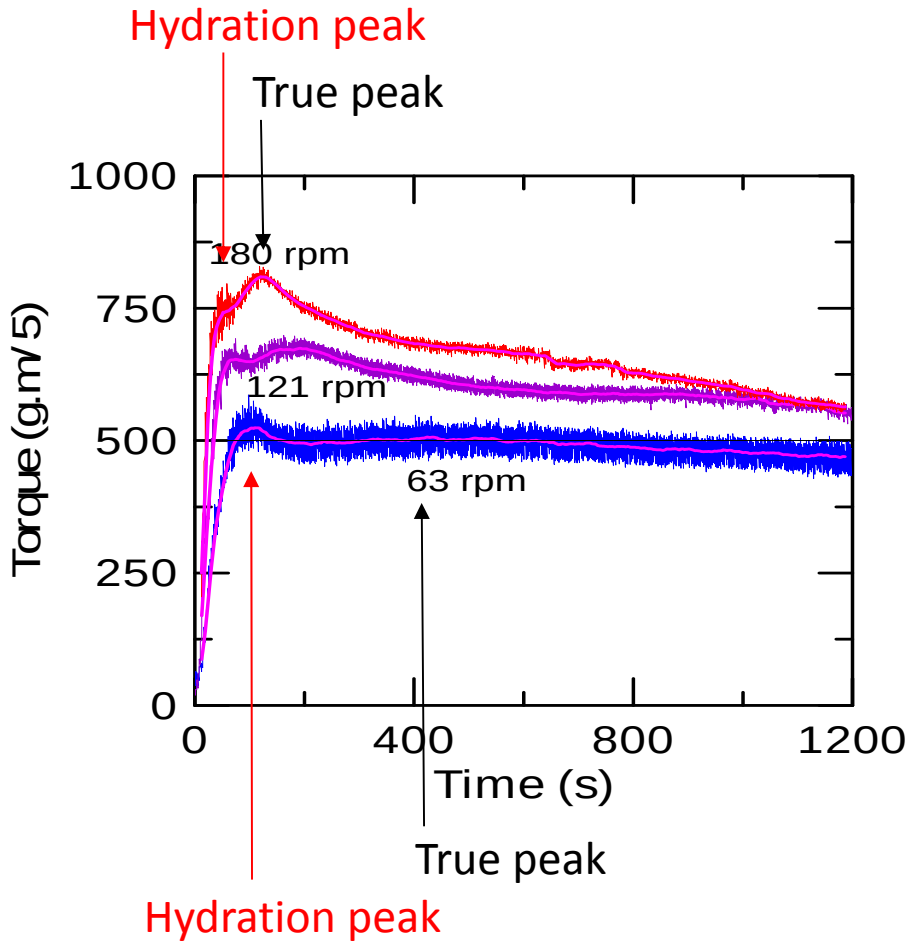
Process relevant

Work rate 3 watt.hr/kg

Similar to modern bakery mixers

Approved

AACCI Method 54-70.01



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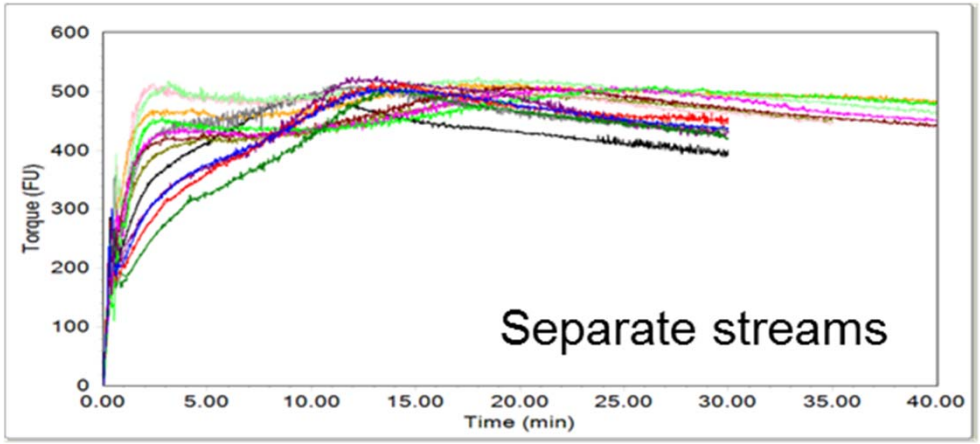
Blending Decisions

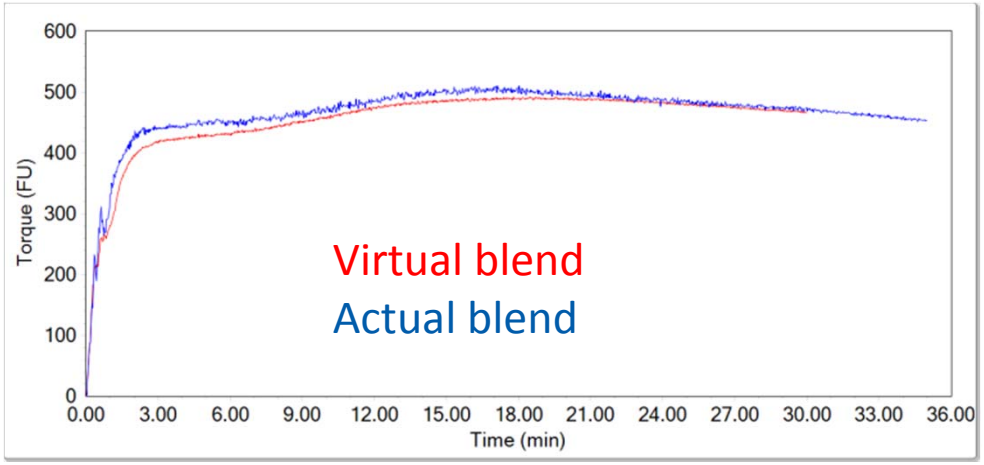
Blend streams virtually in doughLAB software

Try out different mix ratios and instantly see results

Identify optimal mix ratio to meet end-use requirements

Save lab time and reduce the risk of blending mistakes





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micro-doughLAB

- Wheat breeders need simple and rapid methods using small samples to screen large numbers of early generation material
- Cereal researchers need flexibility and innovation
- Flour mills need new methods that provide better measures of flour quality

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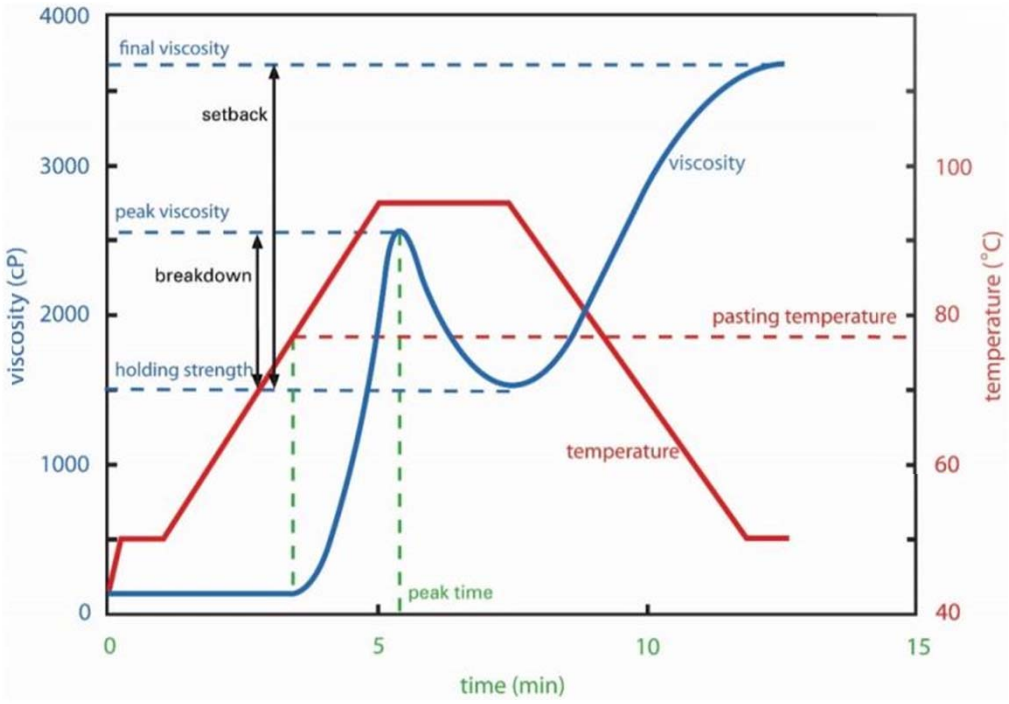
Rapid Visco Analyser

- Rapid heating & cooling rotational viscometer
- Determines starch pasting properties
- Temperature control/Shear control



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RVA - What it measures

- Pastes of plant polymers and associated enzymes
- Starch and starchy products eg. grains, flour
  - Food (thickener, binder, stabilizer)
  - Industrial (paper, adhesives, textiles)
  - Alpha-amylase (sprouting, malting, fungal)
- Protein
  - Dairy, soy, gluten, gelatine
  - Protease, TG
- Gum
  - Carrageenans, Xanthan, Pectin, Arabinoxylan
  - Xylanase

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RVA - What it measures

- The RVA measures and characterizes ingredient performance.
- By subjecting a sample to a reproducible program of heating, cooling, and shear, the RVA provides an apples-to-apples comparison of different samples within each product type.
- Easily and quickly characterize ***ideal*** ingredients for a given product, and compare all future samples directly to that standard.

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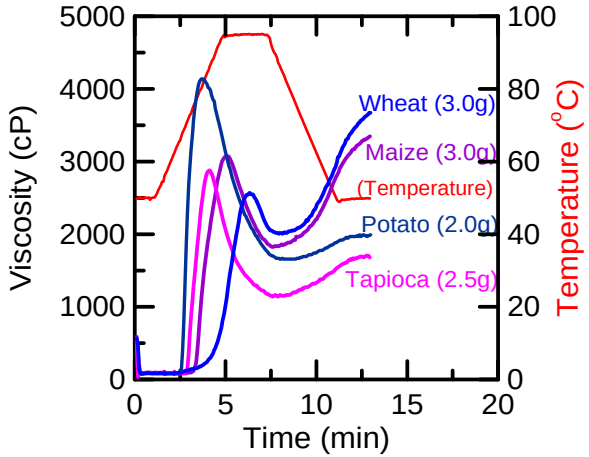
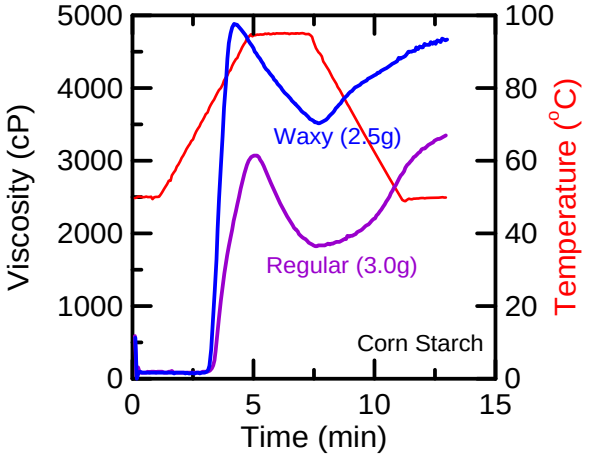
Native Starches

- STD1 most commonly used
- Cereal
  - Higher pasting temp re lipids
  - Strong setback due to amylose
- Root & tuber
  - Higher peaks, lower PT
  - Inhibited setback – phosphorylation in potatoes
- Waxy
  - Lower PT, no lipid binding
  - Low setback, no amylose network
- High amylose
  - Require temp >100°C to paste





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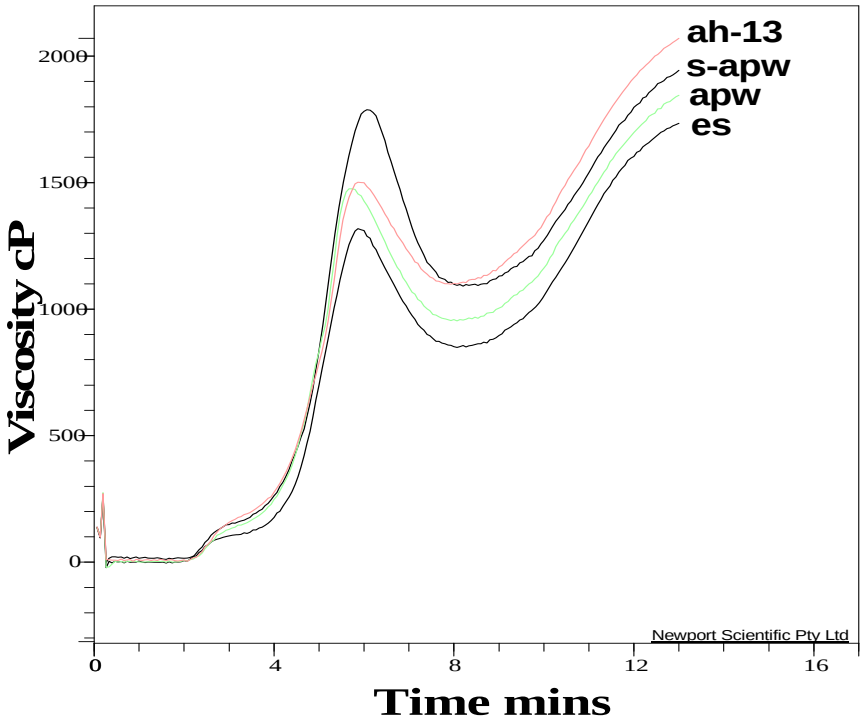
RVA for cookie, cake and noodle flours

Starch pasting characteristics of flour are key to its suitability for cookies, crackers and noodles

The RVA clearly distinguishes flours with different starch properties

Verify flour quality prior to load-out with a simple test



Standard starch pasting methods:
AACCI 76-21.02, ICC 162

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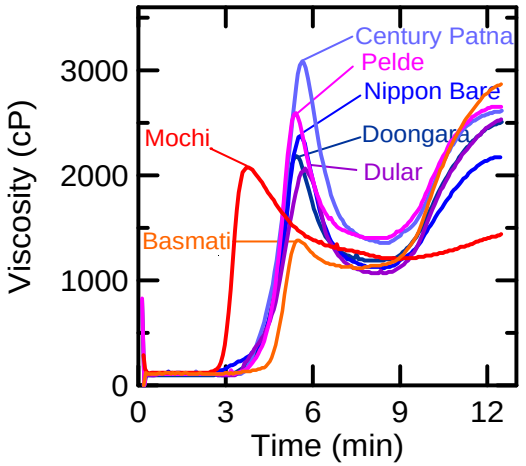
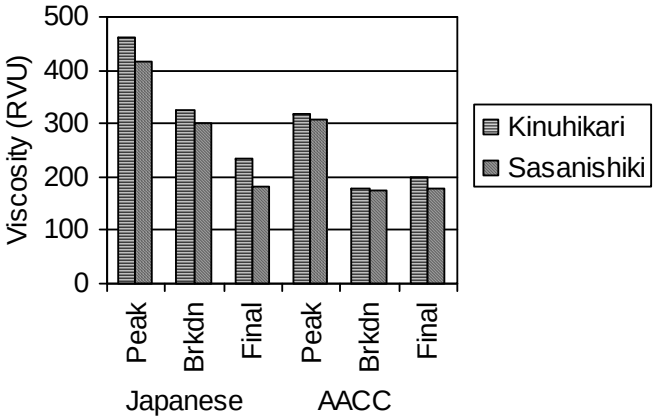
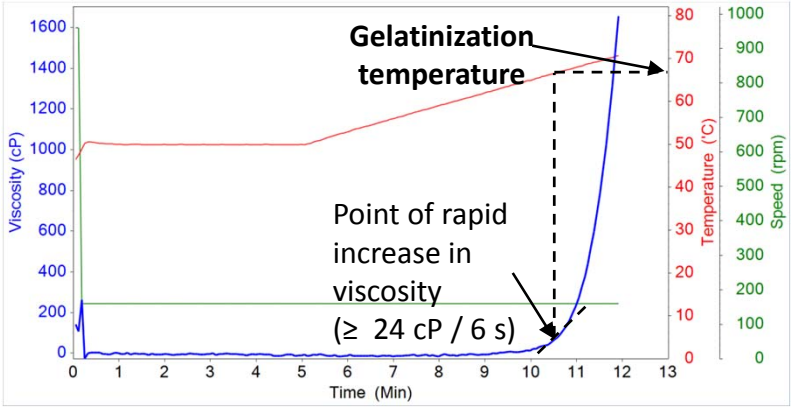
Rice - Quality

- Rapid Rice method (AACCI 61-02)
  - 3.0 g, 12.5 min pasting profile
  - Setback correlates to cooked rice texture
  - Detect effects of variety, aging, particle size, lipid binding
- Japanese method
  - Japanese prefer soft, cohesive rice
  - 3.5g, 19 min method for greater discrimination
- Rice GT method (AACCI 61-04)
  - 6.0 g, slow temperature ramp (3°C/min)
  - More accurately determines gelatinisation temperature







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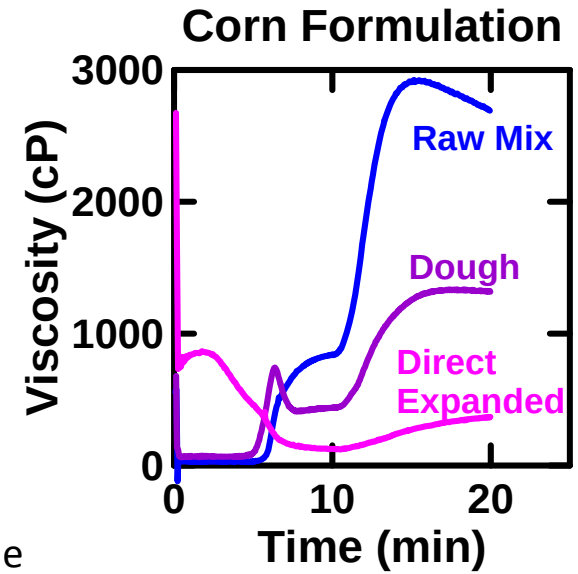
Degree of Cook and RVA Curves

- As degree of cook increases
  - Cold viscosity first rises then falls
  - Peak viscosity and final viscosity decrease
- Interpreting RVA curves
  - More difficult than raw starch
  - Cold viscosity
    - First rises due to pregelling the starch, making it cold soluble
    - Then falls due to dextrinisation and retrogradation
  - Peak and final viscosity
    - Fall due to granule degradation and starch hydrolysis



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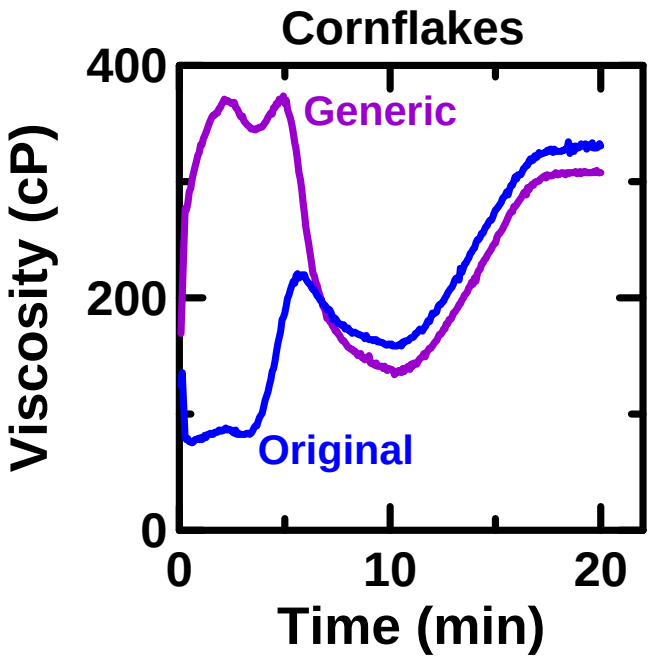
RVA - Application Example

- Reverse engineering
- Original cornflakes
  - Batch cook & flake process, slow & costly
  - Low cold viscosity – good bowl life
- "Copy" product
  - High shear process, ie. extrusion
  - Cold swelling – poor bowl life
  - Could be fixed eg. add surfactant!



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RVA - Approved Methods

- General pasting
  - AACCI 76-21, ICC 162, China FPS LS/T 6101-2002, GB/T 24853-2010
- Stirring Number
  - AACCI 22-08, ICC 161, RACI 05-05, ASBC Barley-12
- Rice pasting
  - AACCI 61-02, RACI 06-05, GB/T 24852-2010
- Rice gelatinisation temperature
  - AACCI 61-04
- Oat pasting
  - AACCI 76-22
- Brewing
  - Mebak II 2.7
- Heat damage in flour
  - FTWG 23

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RVA models

RVA 4500
Widest viscosity range (10-25000 cP) and best precision (+/- 2%). TCW controlled

RVA-TecMaster
Viscosity range (20-8000 cP), precision (+/- 3%). TCW controlled or stand-alone

RVA-StarchMaster2
Viscosity range (20-8000 cP), precision (+/- 3%). Stand-alone (3 methods)

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The RVA is the food labs best friend!

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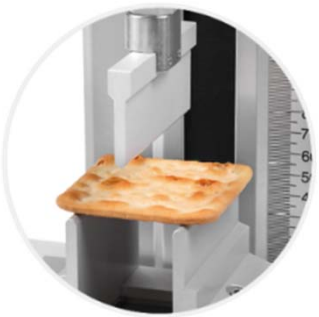
TVT 6700 texture analyzer

- Test Hardness, Springiness, Stickiness, Fracturability, Crispness, Tensile test and much more.
- Monitor staling process



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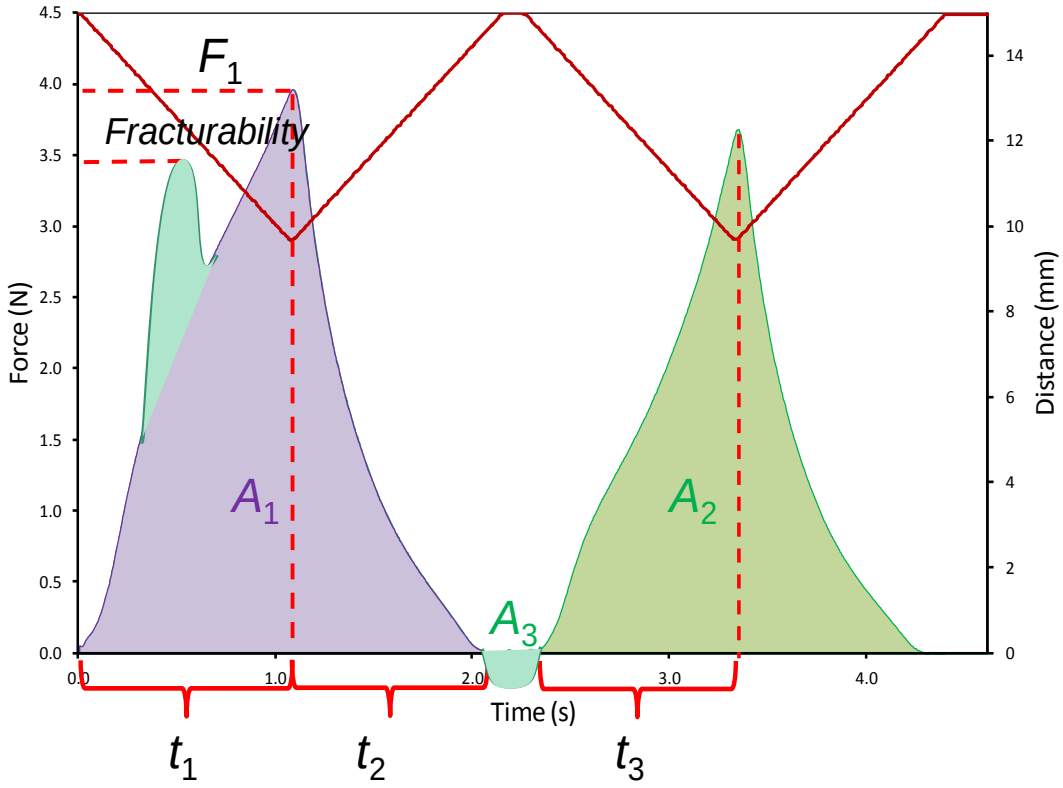
Texture

Fracturability = F1 break (brittle products)

Adhesiveness = A3 (sticky products)

Gumminess = hardness × cohesiveness (solids)

Chewiness = gumminess × springiness (semi-solids)



Hardness = F1

Cohesiveness = A2/A1

Springiness = t3/t1

Graph and definitions courtesy of
Dr. Martin Whitworth – Campden BRI

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Starter Methods & Method descriptions

Perten Instruments Method Description
TVT Method 01.01

AACC 74-09 Bread Crumb Compression Method

Scope

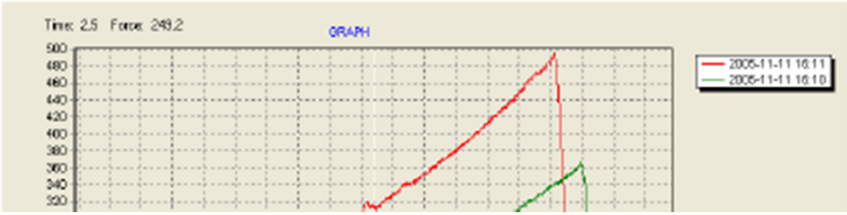
- Bread crumbs are compressed to measure the firmness.

TVT Texture Analyzer

The TVT Texture Analyzer offers rapid and objective analysis of key characteristics, including firmness, crispness, cutting force and elasticity. The instrument includes international standard methods as well as full flexibility for customer tailor-made profiles.
Combining speed, precision, flexibility and automation, the TVT is a unique tool for product development, quality and process control and quality assurance.

Description

The bread crumbs are compressed to measure the firmness. When the probe reaches the trigger force the test commences. The probe will compress the sample to 40% of its height and then the compression stops. The irregularity in the slope of the graphs shows that there have been harder parts in the slices.



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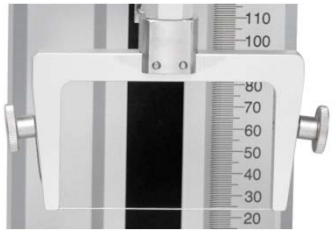
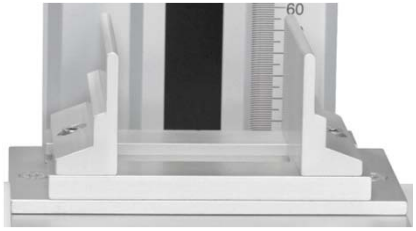
TVT – Large range of Probes and Rigs for a large variation of applications





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BVM volume measurement

BVM: Laser topography analyzer for volume and dimensions of bread and other products.

Official Method: AACCI 10-14.01

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BVM volume measurement

Length

Width

Depth

Weight

Volume

Density

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Comparison trial between Water Displacement – BVM - Seed

Averages (ml)

BVM				
Sample	**Water**	**10 sec**	**60 sec**	**Seed**
A1-A10	1319	1319	1323	1173
B1-B5	1855	1847	1856	1773
B6-B10	1993	1984	1994	1860
C1	1745	1715	1747	1650
C2	2466	2422	2465	2380

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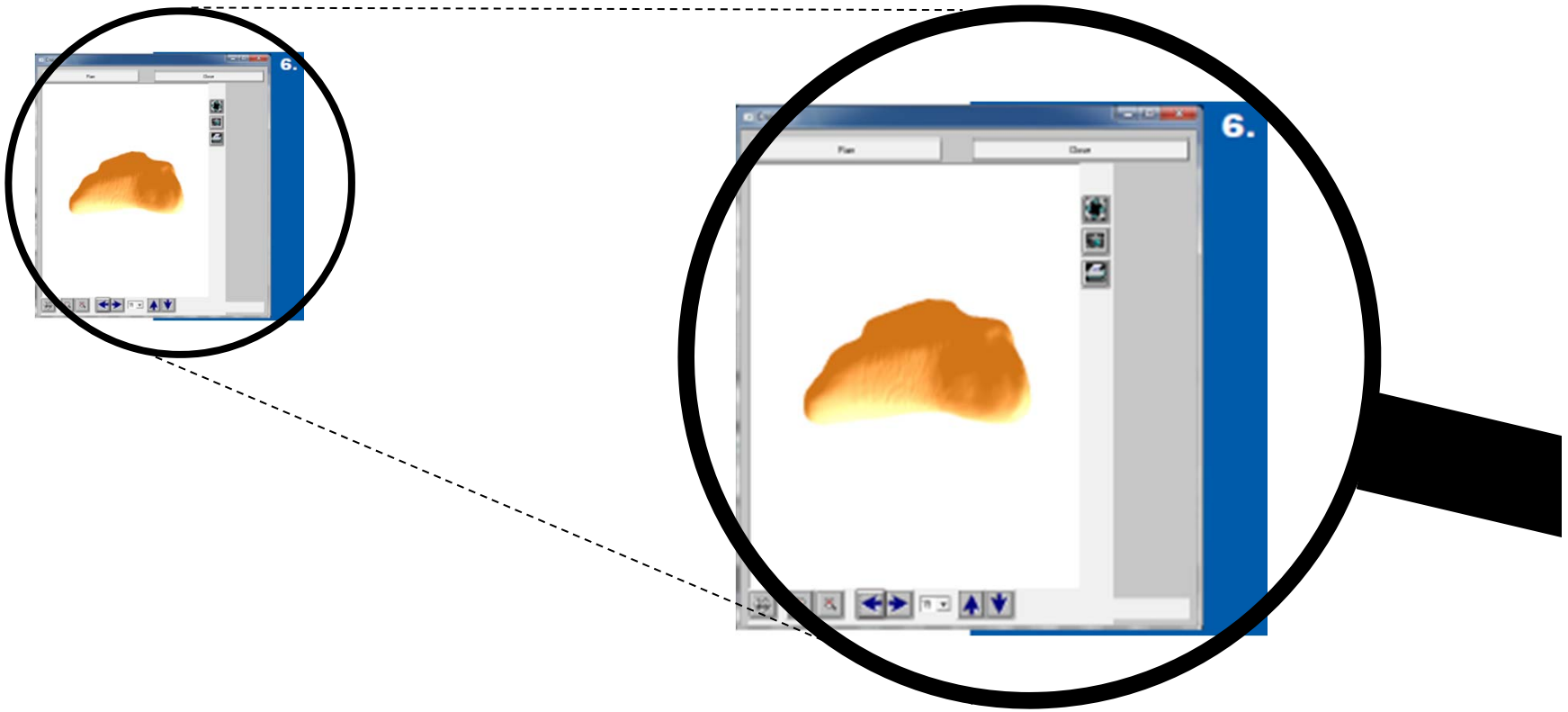
Software – VolCalc

The diagram and the results are displayed
on screen after the measurement and as 3-D Graph.
It is possible to rotate and zoom in and out the diagram.



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Questions

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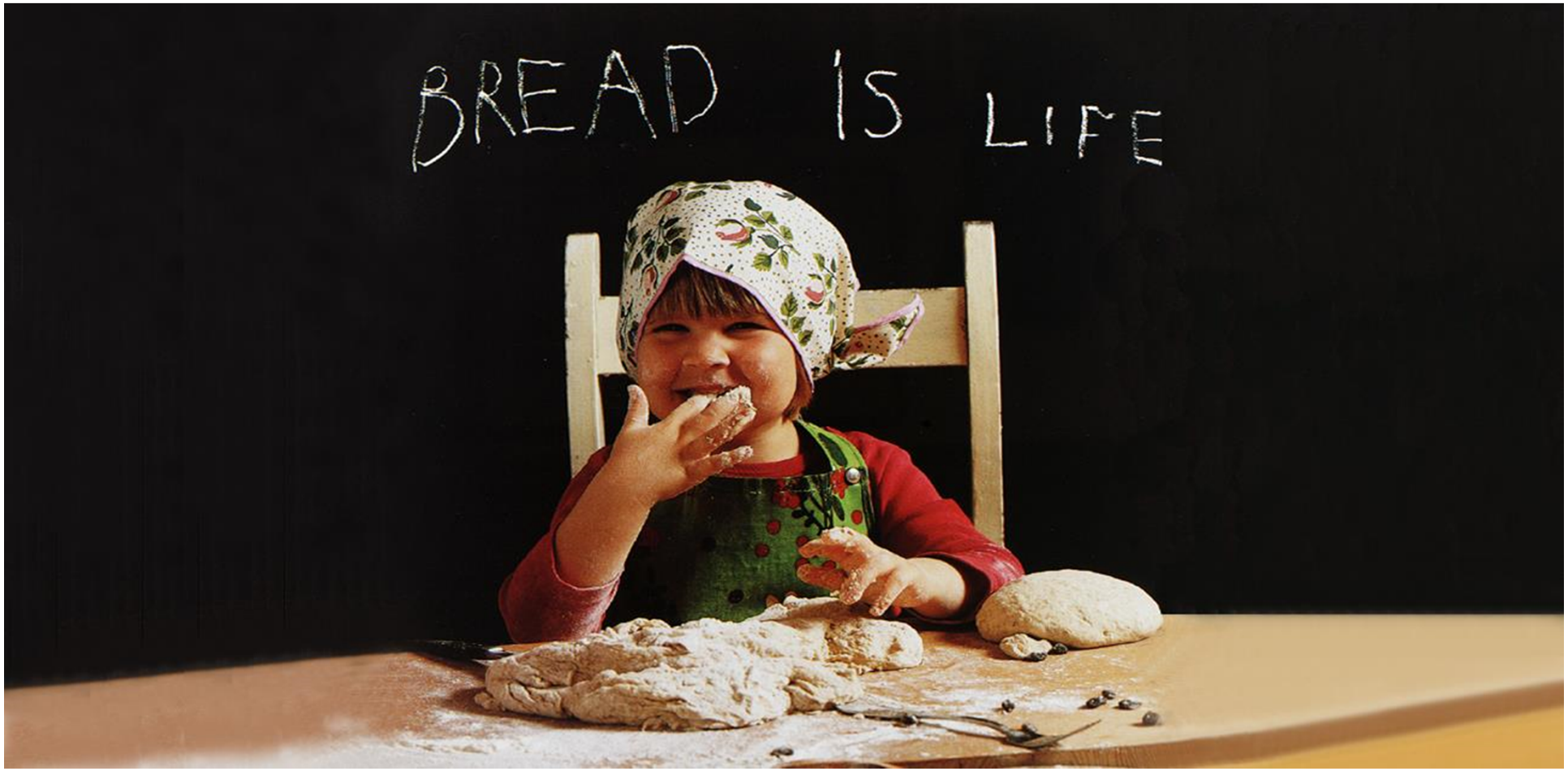
Thank you!



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