Optimizing Flour Quality: A Rapid Visco Analyzer for Flour Millers and Bakers

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Perten Instruments

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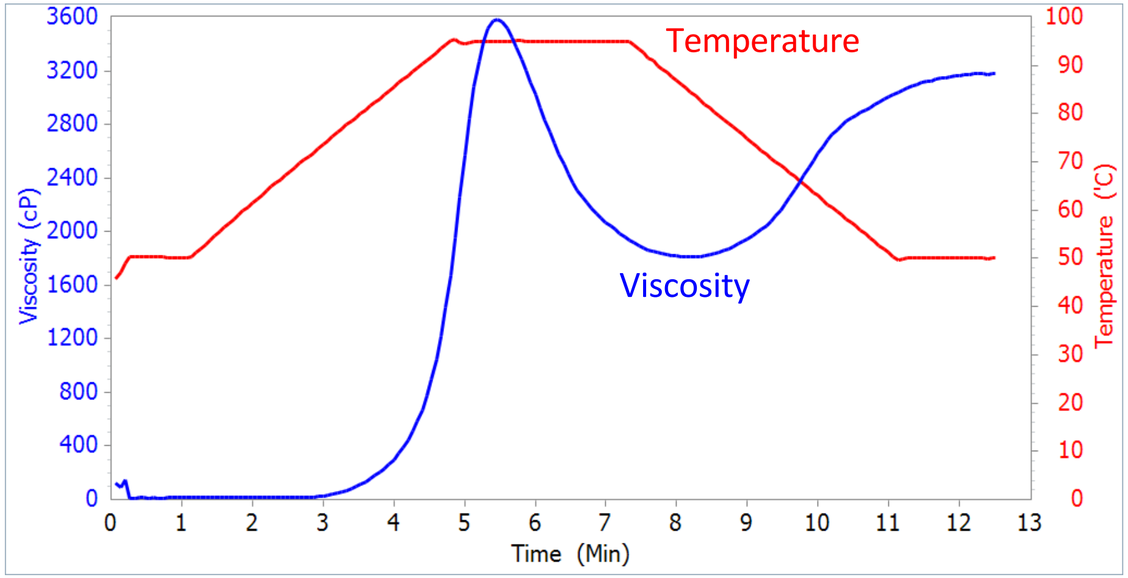
RVA

- The RVA is a cooking viscometer most commonly used to assess the functionality of starch-containing foodstuffs
- Measures viscosity through a precisely controlled cooking profile
- Able to both mimic process and **measure its effect**
- Highly flexible, many applications

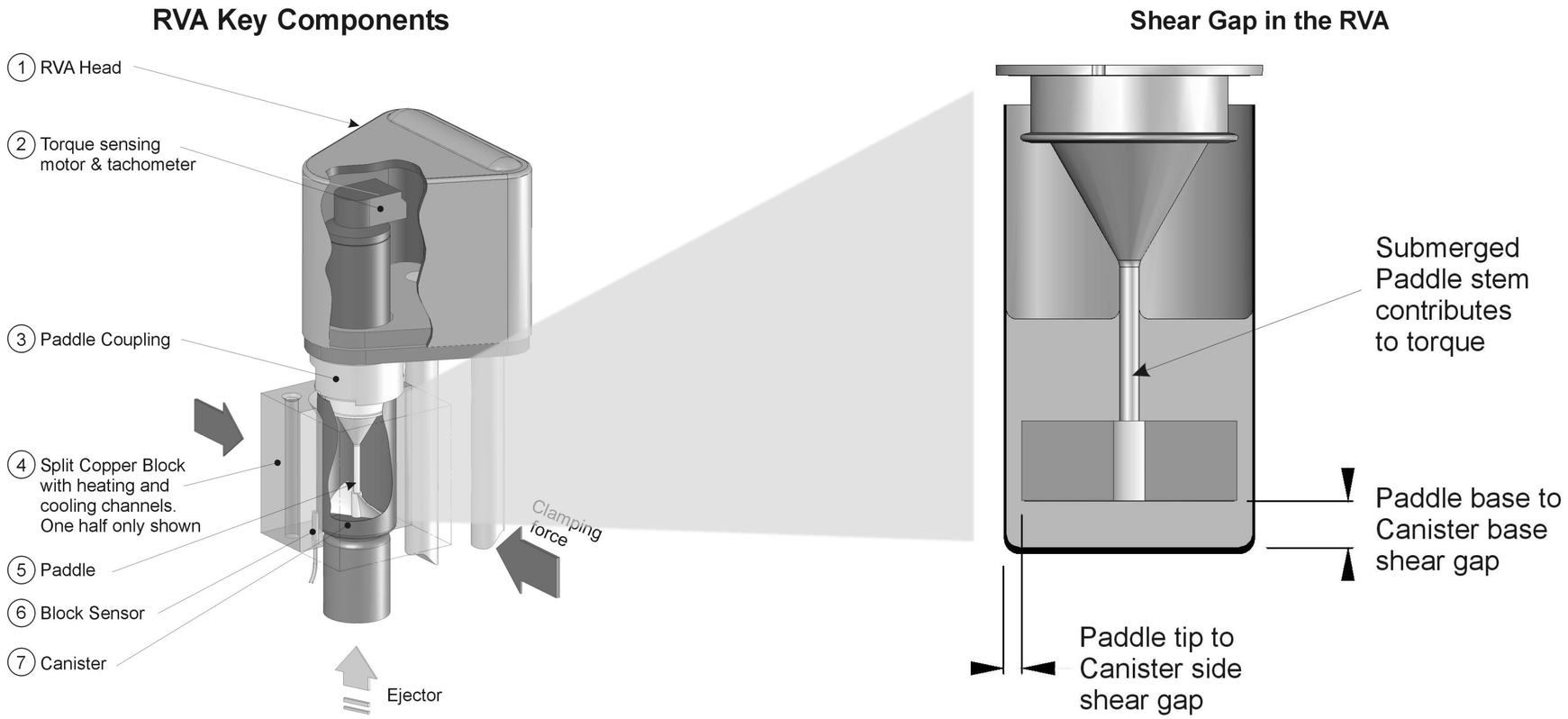


To measure:

- ✓ Raw material quality
- ✓ Effects of formulation, modification, processing
- ✓ Final product quality

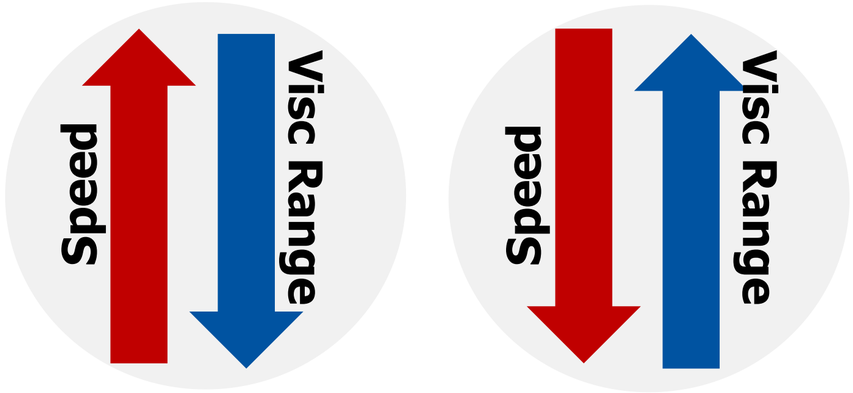
Instrument – Viscosity Measurement on the RVA

- Changes in viscosity recorded under defined conditions of temperature and shear
- Shear gaps between the paddle and canister contribute to the measured viscosity



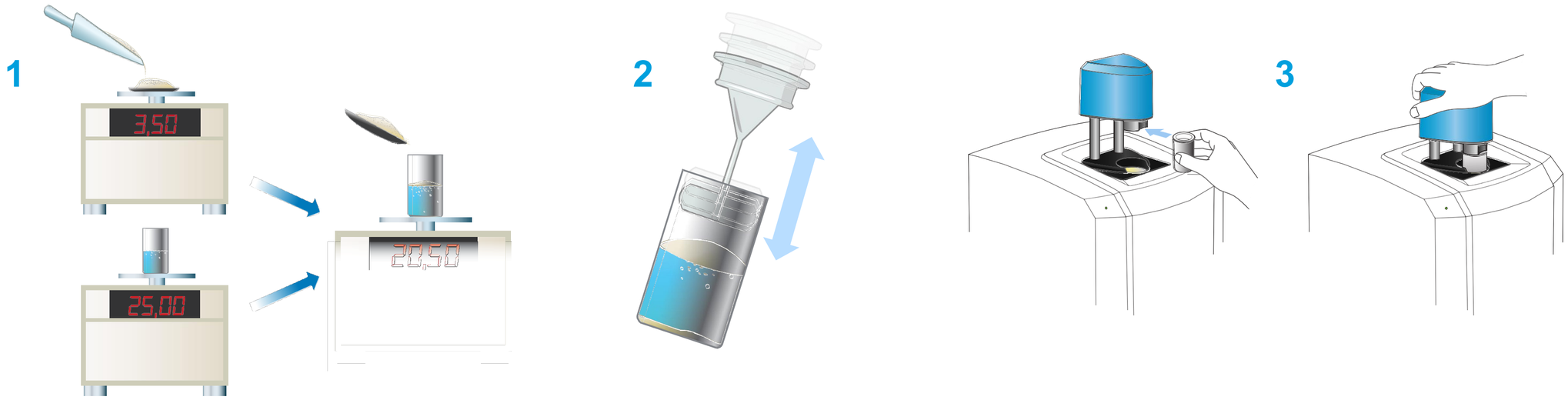
RVA Models

Model	RVA 4500	RVA 4800
Visc **Range** @160rpm (cP)	10 – 35,000	
Speed Range (rpm)	20 - 2000	
Control	PC	
Temp Range (°C)	**0-99**	**0 - 140**
Usage	R&D/work horse	R&D



Operation

1. Weigh solvent/water into canister (25 g) and sample into weigh boat (3 g)
2. Transfer sample onto solvent/water surface in canister
   - Stir to disperse sample (use paddle or stirrer)
3. Insert canister and paddle into RVA and push down the tower
   - Typical low temperature profile 50/95/50˚C, 13 min

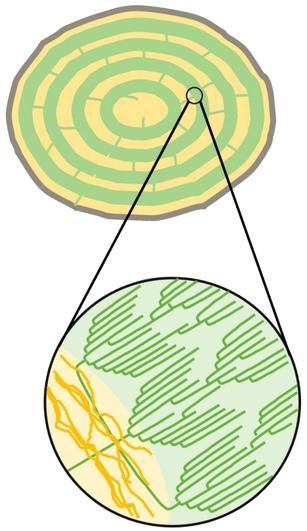


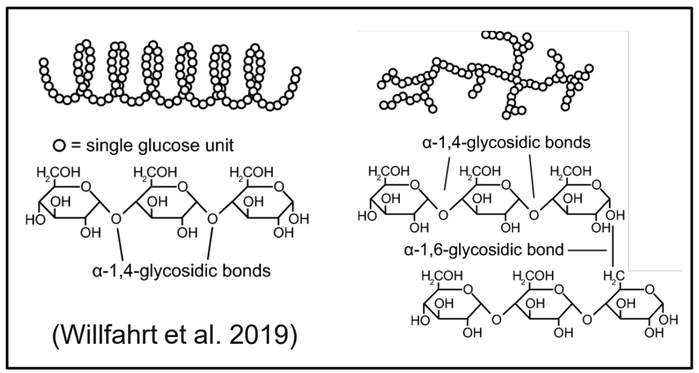
Assay – RVA Starch Pasting Curve

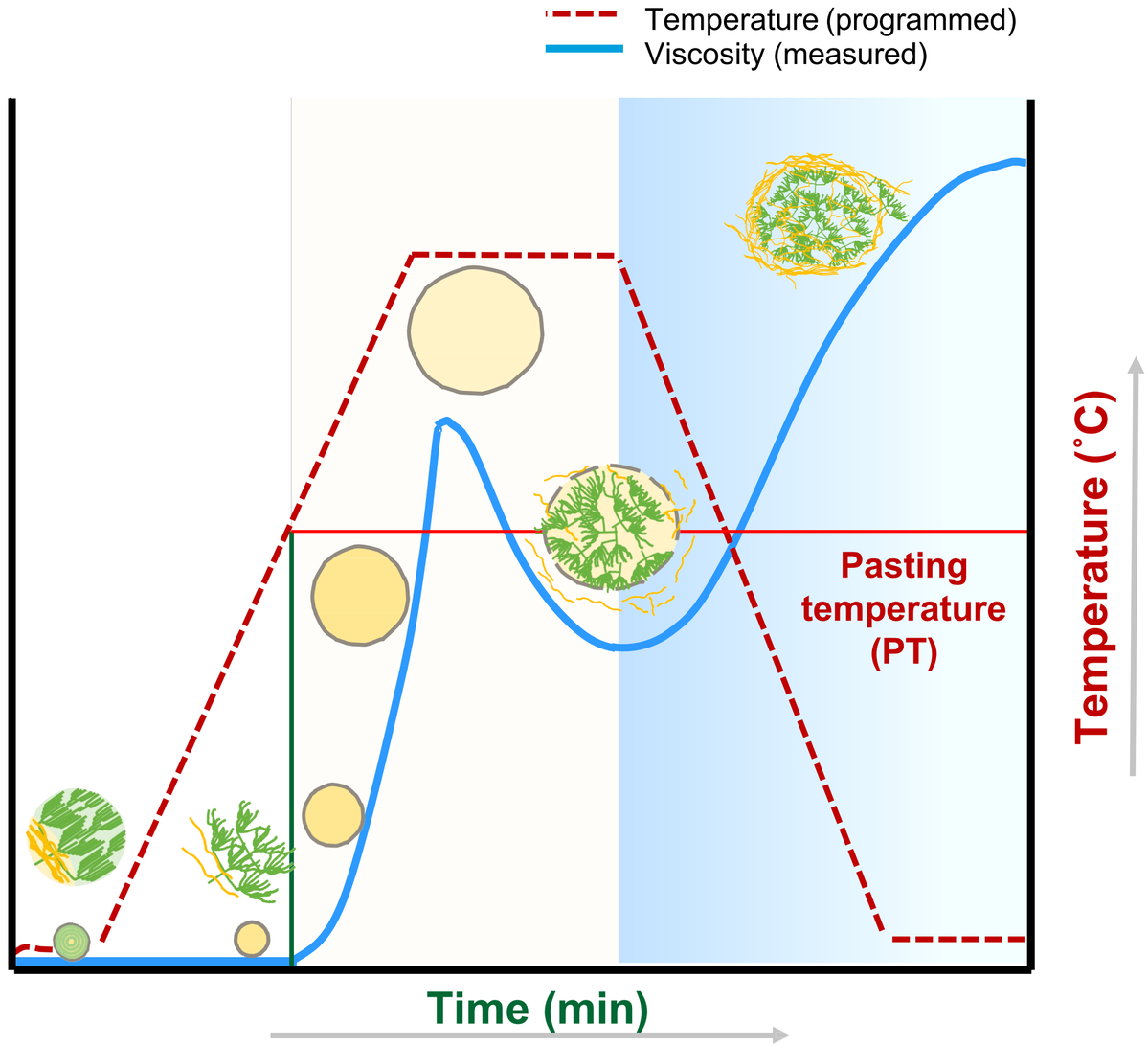
Assay

- Typical profile 50-95-50°C, 13 min
- A viscous paste develops during heating then cooling
  - Starch granules swell and starch polymers leach out into solution
  - The polymers then align under shear and may gel on cooling
  - Other polymer systems can also be measured

Starch granule



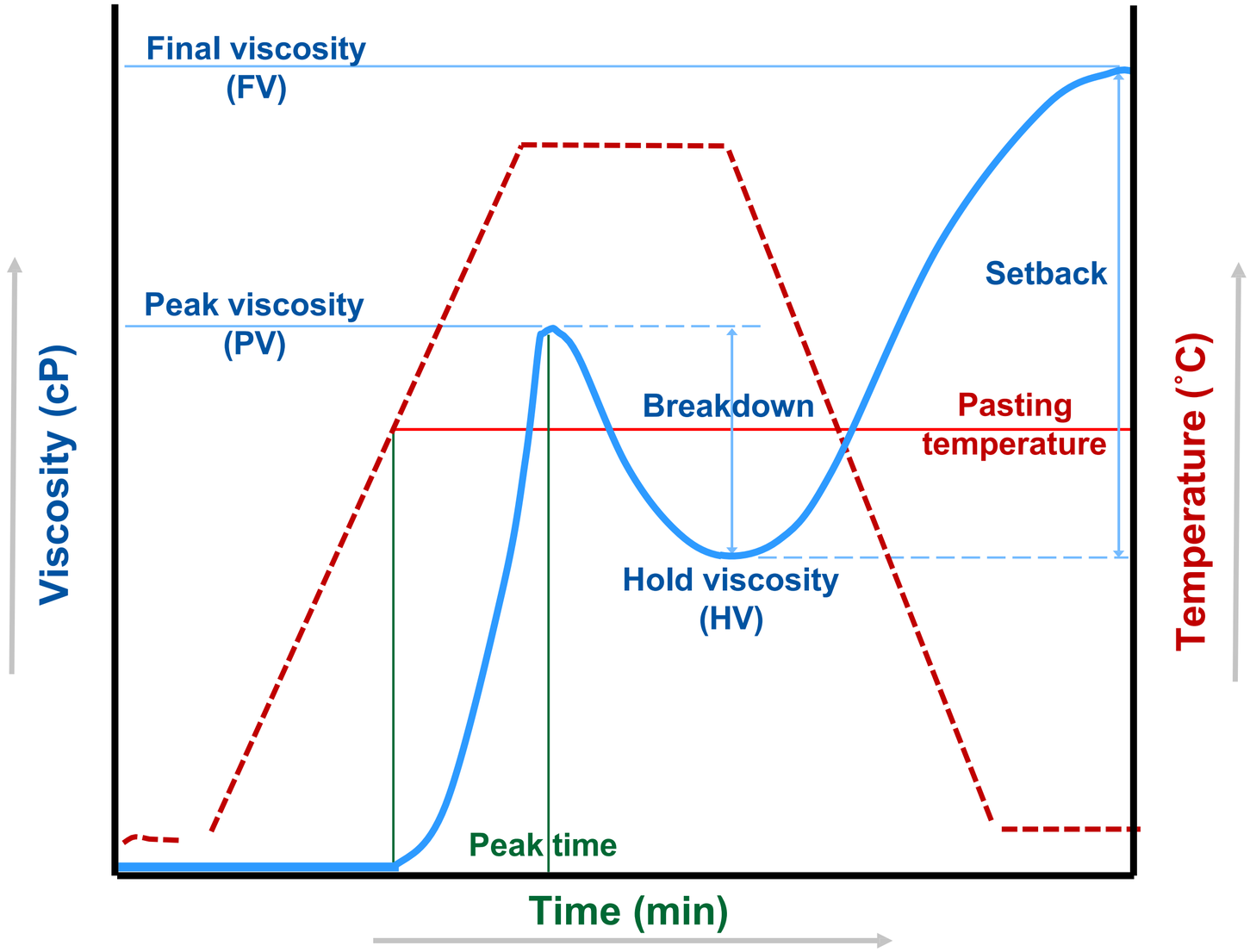




Adapted from Moore, E. *SF&WB Webinar*, 22 April 2022

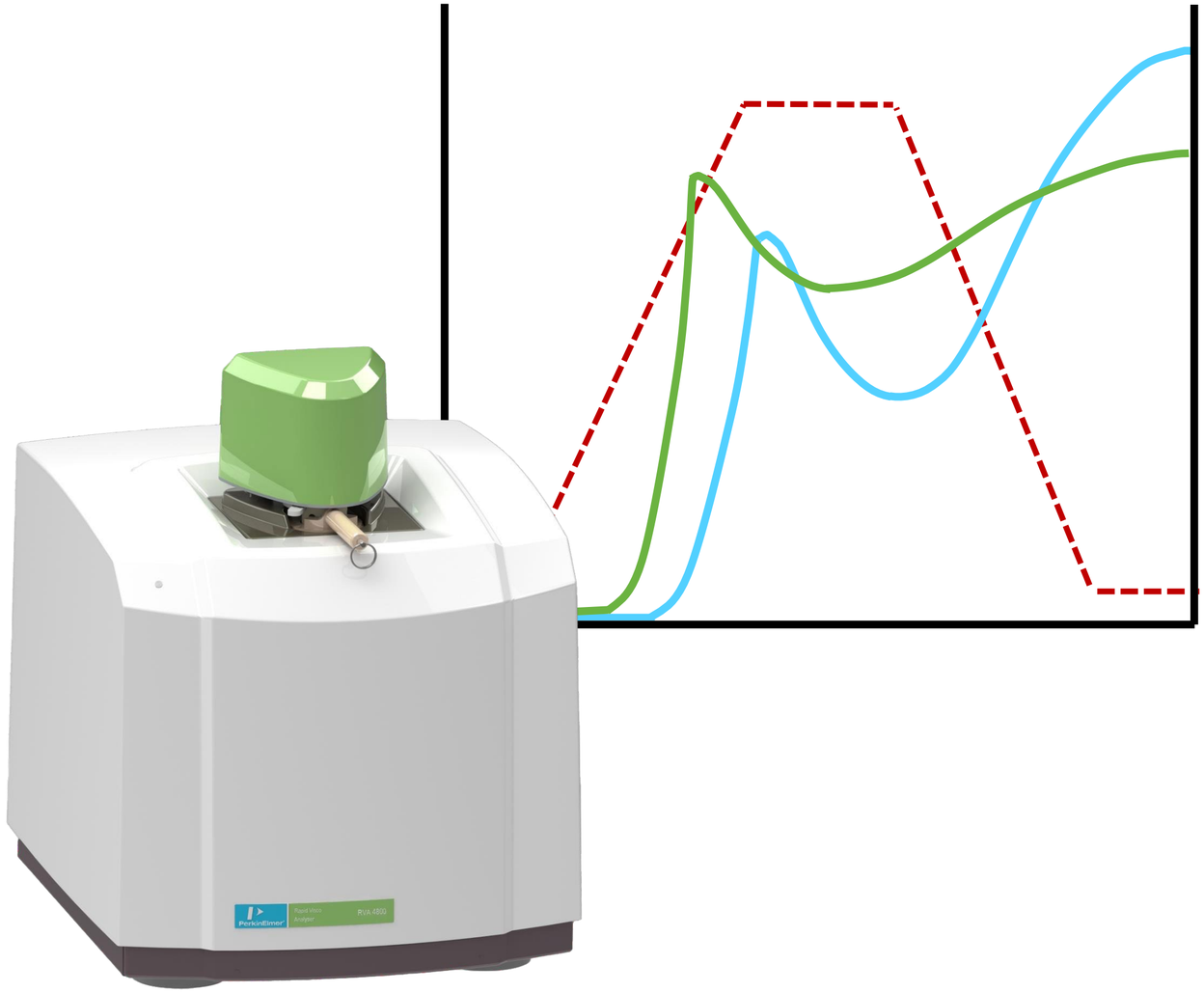
Key Results – Pasting Curve of Raw Starch

- Viscosity curve features
  - Pasting temperature
  - Peak, hold & final viscosities
  - Derived parameters (breakdown, setback)
- Indicate
  - Heating requirement
  - Process tolerance
  - Viscosity forming potential
- Functional performance of the sample



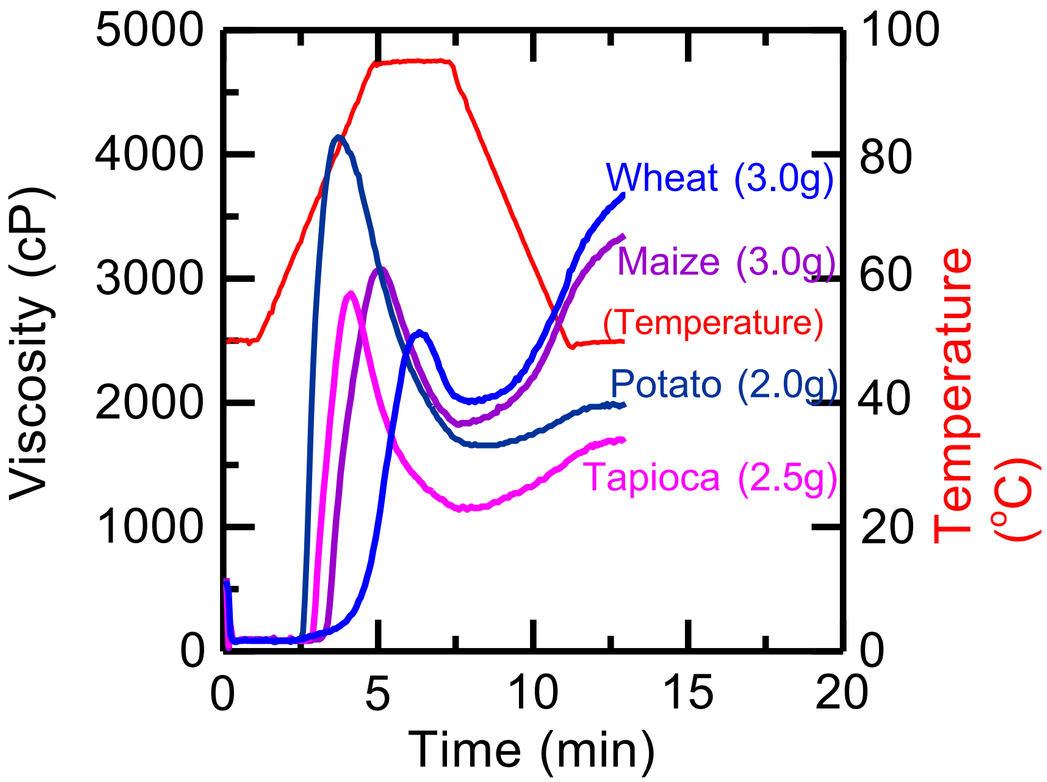
Factors Affecting RVA curves

- **Sample type** (AM/AP Content ratio)
- **Sample concentration**
- **Particle size**
- **Enzymes**
- Profile speeds, temps, heat & cool rates
  - Standard methods are required to make results comparable



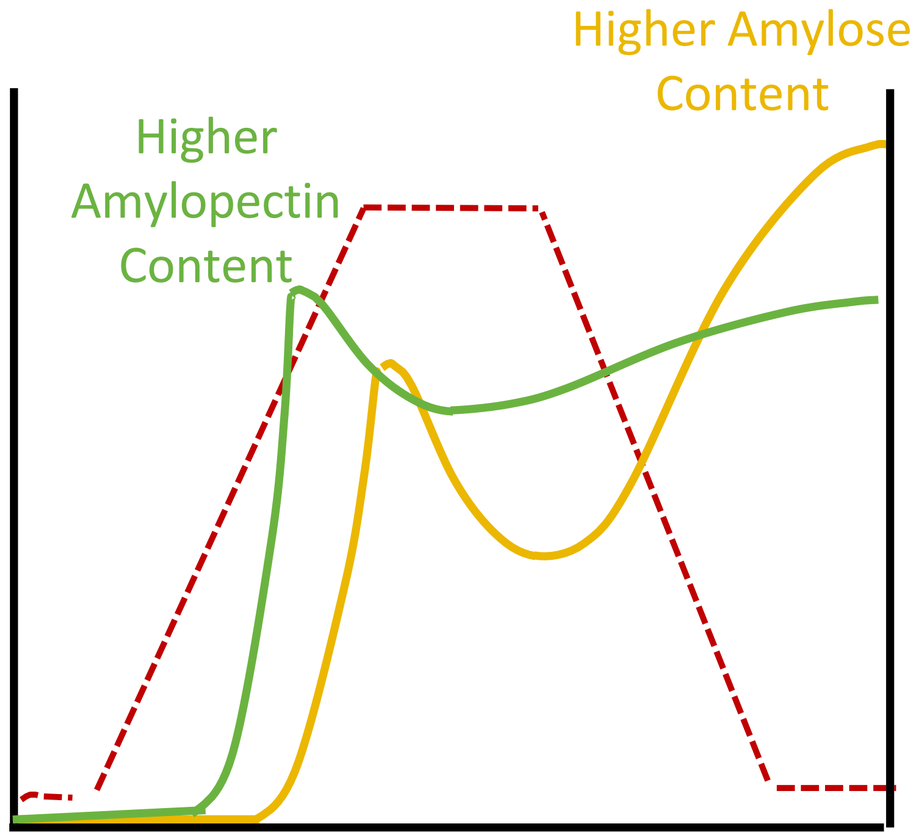
Effect of Starch Source

- Starches differ from different sources
  - Content
  - **Proportion of AM and AP**
  - Conformation
- The RVA is sensitive to these differences



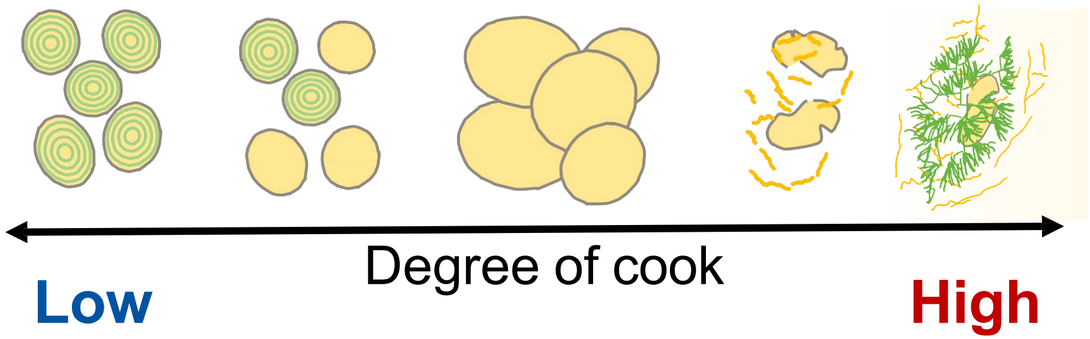
Effect of AM and AP content

Pasting Curve Result	Higher Amylose Content	Higher Amylopectin Content
Pasting Temperature	↑	↓
Peak Viscosity	↓	↑
Breakdown	↑	↓
Final Viscosity	↑	↓



Applications - Measuring Degree of Cook with the RVA

- Re-cook the product in the RVA to determine the original degree of cook
- Fingerprint – thermal and mechanical history of the product shows up on RVA curve
- RVA applications
  - Process control & troubleshooting
  - Scale-up & transfer
  - Product development & specification
  - Reverse engineering



RVA APPLICATIONS

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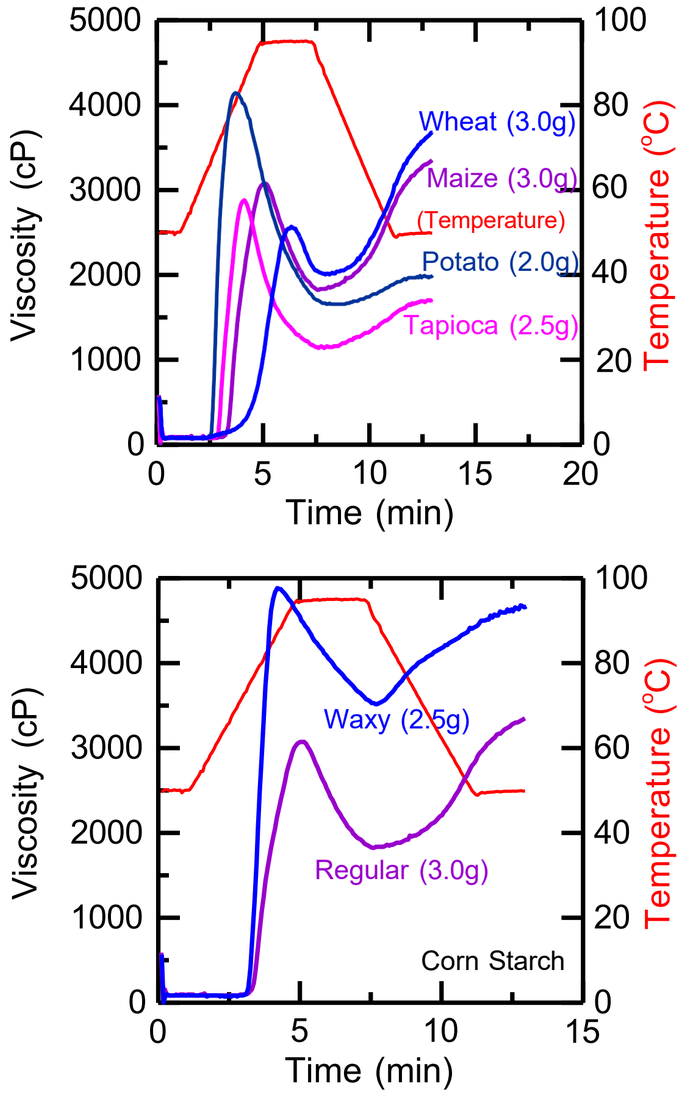
Native Starches

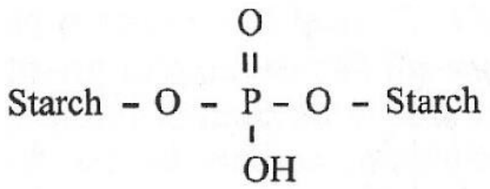
- STD1 most commonly used
- Cereal
  - Higher pasting temp re lipids
  - Strong setback due to amylose
- Root & tuber
  - Higher peaks, lower PT
  - Inhibited setback – phosphorylation in potatoes
- Waxy
  - Lower PT, no lipid binding
  - Low setback, no amylose network
- High amylose
  - Require temp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

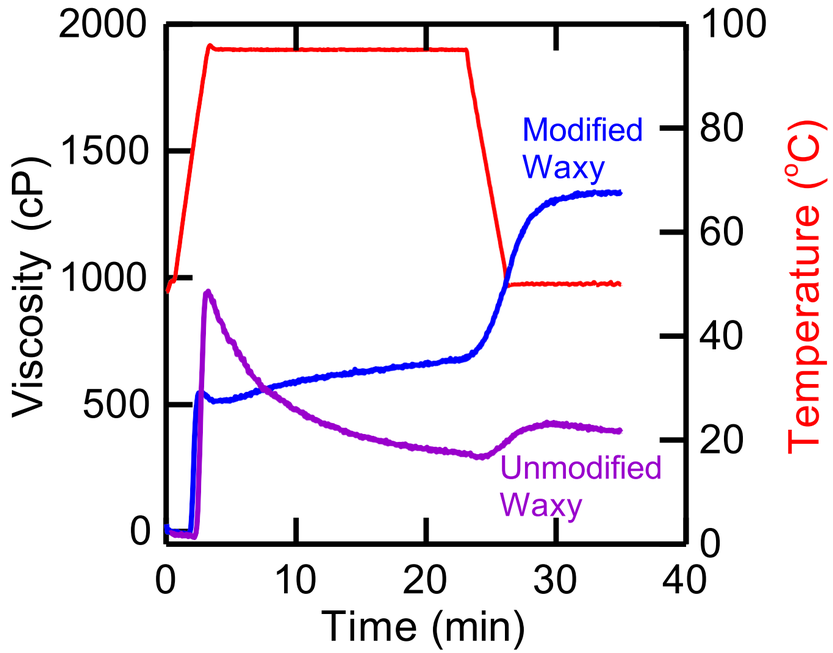


Crosslinked Starches

- ✓ Assess cooked viscosity of unmodified/modified waxy starch.
- ✓ Differentiate starches with different degrees of modification.
- ✓ Quality control of the starch modification process.
- ✓ Quality control of starch used in food manufacture.

- Crosslinking
  - Eg. distarch phosphate
  - Increases resilience to heat, shear and acid
  - Food and industrial uses
- ST-01, ST-02
  - Extended exposure to high heat and moderate shear
  - Stability related to batch cooking processes





Ingredient Screening

Baking flour quality (RVA Method 1)

- STD1 test (ICC 162, AACCI 76-21)
- **Measure amylase – peak & final viscs lowered**
- **Detect heat treatment – peak visc lowered**
- 8x faster than Visco-Amylograph

- ✓ Monitor consistency of flour quality between batches.
- ✓ Monitor effect of heat treatment on flour.
- ✓ Determine the amount of heat treatment needed for desired quality

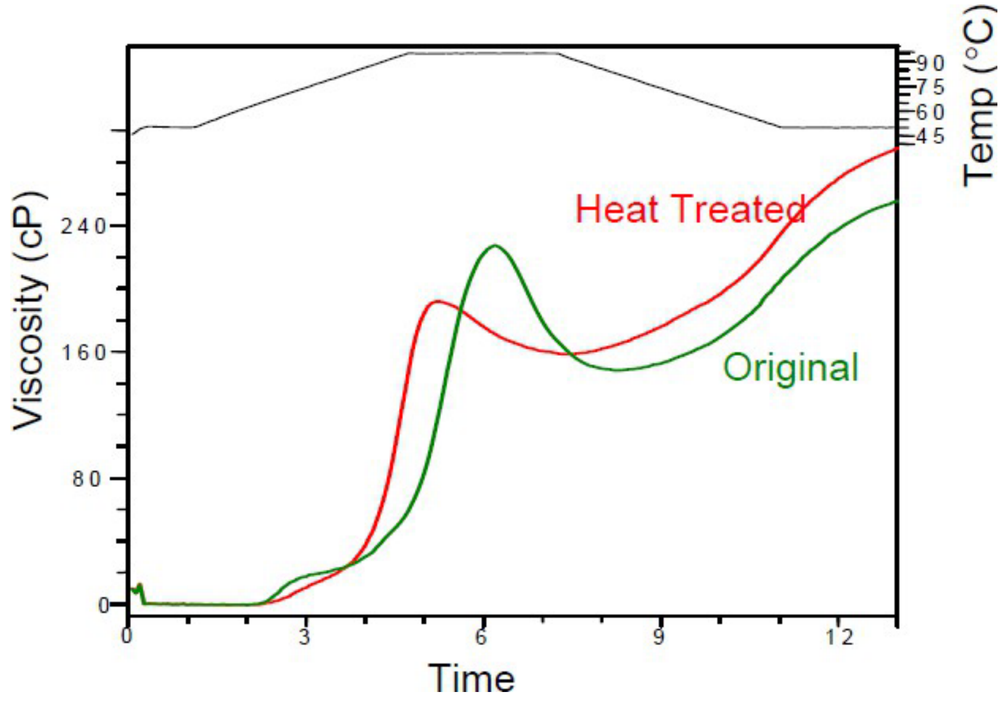


Fig. 1. Pasting curves of heat-treated and non heat-treated flour, both originating from the same source.

Cake Mix Quality Method

RVA Method 34

- STD2 test
  - 23 min test 50-95(5 min hold) -50℃
- Compare cooking behavior of different formulations.
- Develop new formulations.
- Monitor consistency of ingredients between production batches.
- Relate results to final product quality - texture, taste, appearance

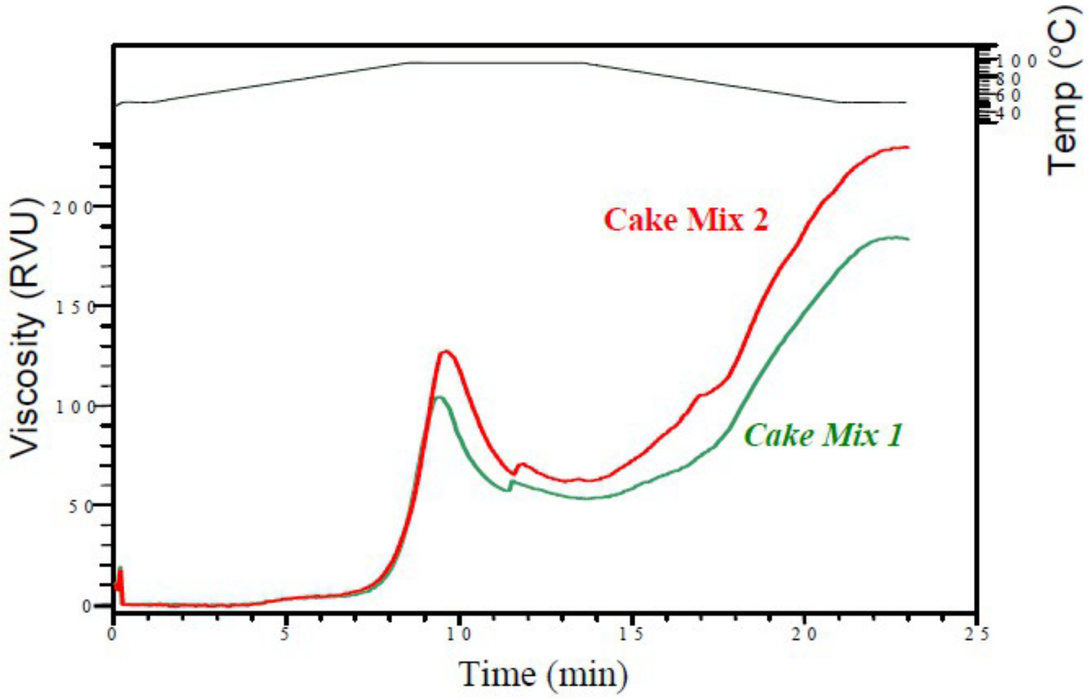


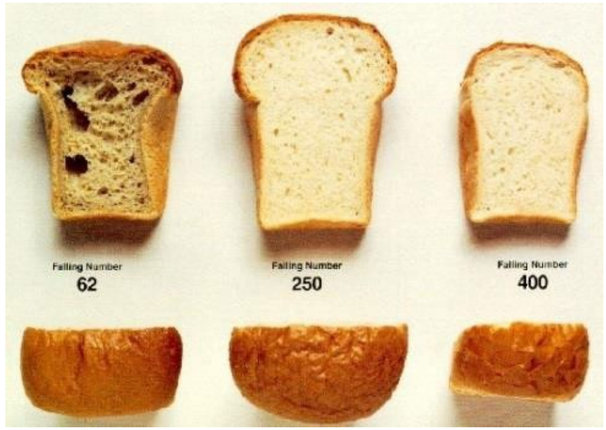
Fig. 1. Pasting curves of competitive cake mixes.

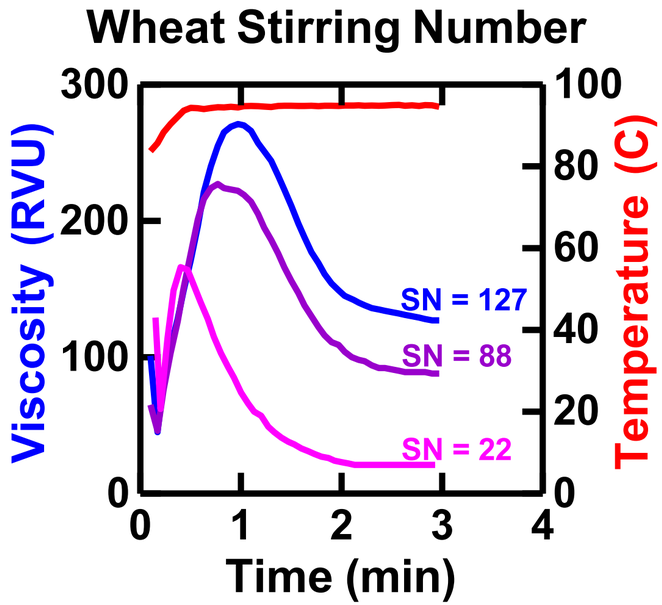
Ingredient Screening

Stirring Number (AACC 22-08)

Bread quality

- Malt (α-amylase) added to enhance yeast fermentation
- Too much αamylase activity in low SN flour results in
  - Sticky dough
  - Dark crumb & crust color
  - Coarser crumb
  - Sticky/gummy texture





Pasta/noodle quality

- Pasta/noodle from low SN flour
  - Is fragile, soft and sticky
  - Starch lost to cooking water – cloudy water
  - Increased production issues
    - Uneven extrusion
    - Strand stretching
    - Irregularities in drying
    - Dough handling and cutting problems

High FN

Low FN

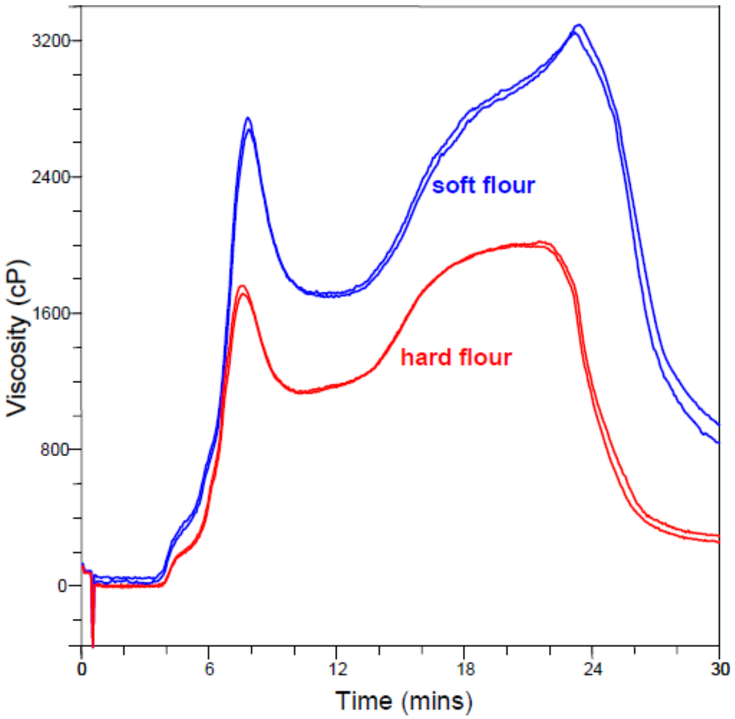
Ingredient Screening

Quality of the gluten protein in wheat flour (RVA Method 24)

- **Sample Preparation**
- 3.00 g flour (12% mb) and 3.5 g ethanol (98%). Stir until no lumps remain. Add 20.0 g distilled water (total amount of water + flour is 23.0 g).

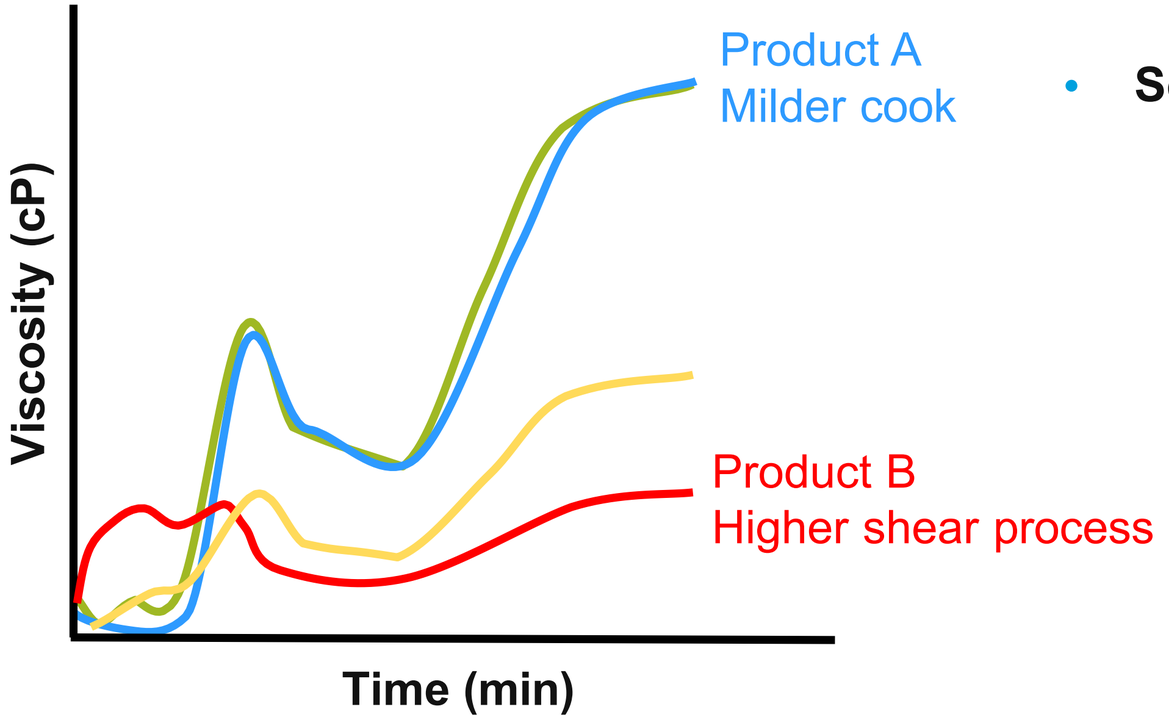
Profile

Time	Type	Value
00:00:00	Temp	50°C
00:00:00	Speed	960 rpm
00:00:30	Speed	160 rpm
00:02:00	Temp	50°C
00:06:30	Temp	85°C
00:08:30	Temp	85°C
00:24:00	Temp	20°C
00:30:00	End	

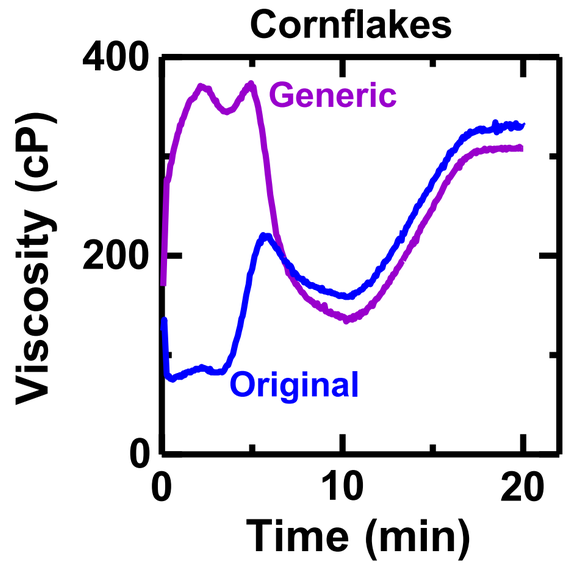


The viscosity of the second peak is the RVA Wheat Flour Ethanol Index.

Reverse Engineering



- **Problem**
  - Extruded RTE breakfast cereal has short bowl life
- **Root cause**
  - High mechanical shear in extrusion damages starch causing rapid hydration in finished product
- **Solution (RVA Method 13)**
  - Fingerprint original batch-cooked product with RVA
  - Adjust extrusion process to better match original by reducing friction using a ‘process aid’ (surfactant)



Adapted from Moore, E. *SF&WB Webinar*, 22 April 2022. LINK

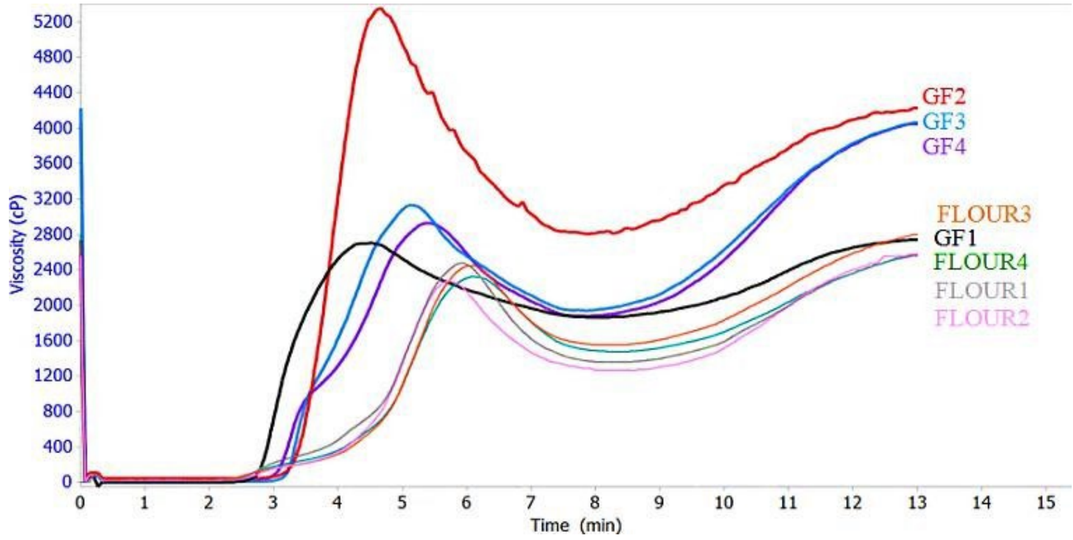
Product Development – Gluten Free Formulation

Gluten free products

- Are costly to produce, and are generally inferior to their gluten-containing counterparts
- Lack gluten for development of strong dough
- Rely on other ingredients (starch/gums/other proteins) in formulation for viscosity and “bulk”

Standard 1 (RVA Method 1)

- Able to differentiate between and within the GF and wheat flour samples
- Greater discrimination among the GF flours due to their higher and more varied starch and/or gum contents
- Broad peak generally indicates a protein source



Internationally Approved Methods

- General pasting
  - AACC 76-21, ICC 162, China FPS LS/T 6101-2002, GB/T 24853-2010
- Stirring Number
  - AACC 22-08, ICC 161, AGSA 05-05, ASBC Barley-12
- Rice pasting
  - AACC 61-02, AGSA 06-05, GB/T 24852-2010
- Rice gelatinisation temperature
  - AACC 61-04
- Oat pasting
  - AACC 76-22
- Brewing
  - Mebak II 2.7
- Heat damage in flour
  - FTWG 23
- βglucan in cereal products
  - AACC 32-24

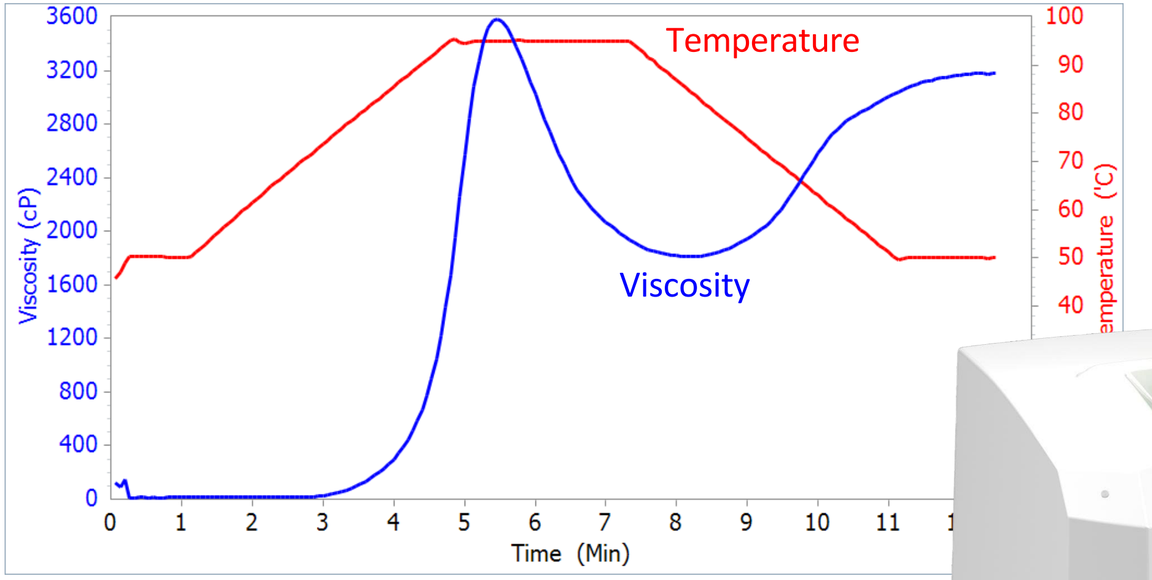
Perten Methods

1. General pasting
2. Stirring Number
3. Malt flour
4. Fungal amylase
5. Wheat and rye flour
6. Corn starch
7. Potato starch
8. Acid modified starch
9. X-linked/substituted starch
10. Rice (rapid)
11. Durum
12. Asian noodle
13. Extrusion
14. Barley storage
15. Malting barley
16. Kilned malt
17. Brewing adjuncts
18. Soup
19. Cellulase
20. Custard powder
21. Wheat gluten (acid)
22. Japanese rice
23. Sweet potato starch
24. Wheat flour (ethanol)
25. Wheat gluten (ethanol)
26. Skim milk powder
27. Whey protein conc.
28. Joint cement
29. Rennet caseinate
30. Cheese melt
31. Solvent retention
32. Pasta
33. Flour heat treatment
34. Cake mix
35. Xanthan hydration
36. Fermentable starch EtOH
37. Fermentation quality
38. Mash viscosity
39. Distillery process
40. Insect protease
41. Gum gelling
42. Pregelatinized starch
43. Rice gel temperature
44. 91C general pasting method
45. High temp general pasting method
46. Retorting method
47. High temp gum method
48. Jet cooking method
49. Retrograded starch method

Staley (Tate & Lyle) Methods

ST-00. General method
ST-01. Cook-up waxy food starches
ST-02. Cook-up dent food starches
ST-03. Ethylated starches
ST-04. Cationic starches
ST-05. Acid thinned starches
ST-06. Unmodified dent starches

... and growing



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Thank you!