Using the SRC Test Method as a tool for millers.

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Thanks and Notes:

• Thanks to my colleague Mr Peter Lloyd, Regional Technical Director from our Casablanca, Morocco office for sharing much of his valuable research on the milling part of this subject.

• Thanks also to the team at the Wheat Marketing Center of Portland, OR for teaching me all about SRC.

• Disclaimer: I am a simple baker and not a cereal scientist or a miller and do not pretend to know all about cereal chemistry or milling!
Why am I excited about SRC?

• SRC provides a quick, inexpensive way to give us a Functionality Profile for flour.
• Relatively linear response gives us the opportunity to use this test to blend.
• Proven success with soft wheat, which is moving now to hard (bread) wheat testing.
• Cumulative functionality testing of mill streams is now a possibility (previously prohibitively expensive outside Japan).
• Developed originally by the Nabisco Company in the US for cookie and cracker flour.

• SRC technology is a unique diagnostic tool for predicting flour functionality, and its applications in soft wheat breeding, milling, and baking are increasing markedly as a consequence of many successful, recently published demonstrations of its extraordinary power and scope.

• Increasingly SRC is being used in hard wheat applications for baking.
• SRC examines the glutenin characteristics of the flour, pentosan content and the starch damage from the milling process.

• These values describe the functionality of the flour’s ability to absorb water during the mixing process and its ability to release that water during the baking process.

• The combined pattern of the four SRC values establishes a practical flour quality/functionality profile useful for predicting baking performance and specification conformance.
Four solvents are independently used to produce four SRC values:

– 50 percent **Sucrose SRC**; associated with pentosan characteristics

– 5 percent **Sodium carbonate SRC**; associated with levels of damaged starch

– 5 percent **Lactic acid SRC**. associated with glutenin characteristics,

– **Water SRC**; is influenced by the other three SRC values.

*(Solvent Retention Capacity Profile 2009).*

• SRC values are expressed as percent of flour weight, on a 14 percent moisture basis.
Gluten Performance Index

• A new predictive SRC parameter, the gluten performance index (GPI), defined as

\[
\text{lactic acid SRC} \quad \frac{\text{(sodium carbonate SRC+ sucrose SRC)}}{}
\]

• has been found to be an even better predictor of the overall performance of flour glutenin in the environment of other modulating networks of flour polymers.

* AACC
Solvent Retention Capacity (SRC)
AACC Method 56-11
## Flour Composition

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Water</td>
<td>13 – 14 %</td>
</tr>
<tr>
<td>Starch</td>
<td>70 – 75 %</td>
</tr>
<tr>
<td>Protein</td>
<td>9 – 14 %</td>
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<tr>
<td>Pentosans</td>
<td>&lt; 2 %</td>
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<tr>
<td>Fat</td>
<td>&lt; 1%</td>
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<tr>
<td>Ash</td>
<td>&lt; 1 %</td>
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</tbody>
</table>
## Literature Values for Water Holding Capacity


<table>
<thead>
<tr>
<th>Components</th>
<th>Water Holding Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gluten (gliadins and glutenins)</td>
<td>2.8 g H₂O / g dry gluten</td>
</tr>
<tr>
<td>Non glutenin proteins</td>
<td>Negligible</td>
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<tr>
<td>Pentosans (Soluble and Insoluble)</td>
<td>10 g H₂O / g dry pentosan</td>
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</tbody>
</table>

### Starch

<table>
<thead>
<tr>
<th>Condition</th>
<th>Water Holding Capacity</th>
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</thead>
<tbody>
<tr>
<td>Native raw</td>
<td>0.3 - 0.45 g H₂O/g dry starch</td>
</tr>
<tr>
<td>Damaged raw</td>
<td>1.5 – 10 g H₂O/g dry starch</td>
</tr>
<tr>
<td>Gelatinized/pasted</td>
<td>≥ 10 g H₂O/g dry starch</td>
</tr>
</tbody>
</table>
Link Functional Components to Flour Specifications?


Gluten

Pentosans

Starch
  Native
  Damaged

Protein

Gluten vs. Nongluten
Gliadins vs. Glutenins

Pentosans ≠ Ash

Moisture
Protein
Ash
Acid viscosity
P
L
W

Alveograph

Idealize Alveograph Profile - cookies


1. $P = 35 \pm 5$
2. $W = 90 \pm 15$
3. $L = 100 \pm 10$

Quality Consistency

4. SRC: $WRC < 51\%$

$W = \text{area}$
How Can We Measure Contributions From Functional Components Directly?

Slade, & Levine (1993h)

**DIAGNOSTIC SOLVENTS**

**PHYSICAL CHEM**
- WATER *
- SUCROSE-WATER *
- LACTIC ACID **
- Na CARBONATE *

**BIOCHEM**
- PENTOSANASE
- a-AMYLASE
- PROTEASE

**EXPLORE**
- ALL
- PENTOSANS
- GLUTENINS
- DAMAGED STARCH
- GLUTEN

**MIMIC**
- SALTINES
- RICH CRACKERS
- SWEET CRACKERS
- COOKIES
- SPONGE
- ~ ALKALINE NOODLES

* WHITE & WHOLE WHEAT FLOURS FOR RAPID MICRO BREEDERS' SCREENING
** ONLY WHITE FLOOURS DUE TO ANOMALOUS ACID SWELLING BRAN
SRC Standard Diagnostic Solvents

Deionized Water

- 5% Lactic Acid
  - Glutenins

- 5% Sodium Carbonate
  - Damaged Starch

- 50% Sucrose
  - Pentosans

Reference
SRC PROCEDURE
(AACC Method 56-11)

Selective Solvation
5 g Flour
25 g Solvent
20 min Solvation

Centrifugation
1000 g (Gravity)
15 minutes

Drainage
Overturn 180° angle for 10 minutes
SRC PROCEDURE

Selective Solvation

- Weigh 5 g of flour
- Weigh 25 g of each solvent: Water, 50% Sucrose, 5% Lactic Acid and 5% Sodium Carbonate
SRC PROCEDURE

- Start the timer
- Pour the solvent into the flour samples
- Shake the mixture well
SRC PROCEDURE

- Shake the mixture every 5 minutes
- Shake the mixture for 5 times
- Each time, shake the mixture for 5 seconds
**SRC PROCEDURE**

**Centrifugation**

- Place the samples into the Centrifuge
- Centrifuge the samples for 15 minutes at 1000 g

![Image of centrifuge](image-url)

**Solid Residue**
SRC PROCEDURE

Drainage

- Decant supernatant
- Overturn tubes to drain off excessive solvent for 10 minutes
- Cap tubes before weighing
SRC PROCEDURE

- Weigh the drained samples
- Calculate the weight gain - SRC is the weight of solvent held by flour after centrifugation

\[
\% \text{ SRC} = \left[ \frac{\text{Gel weight}}{\text{Flour weight}} \times \left( \frac{86}{100 - \% \text{ flour moisture}} \right) - 1 \right] \times 100
\]

Report:
- SRC Water
- SRC Sucrose
- SRC Lactic Acid
- SRC Sodium Carbonate
Significance of SRC Test Solvents (1)

- When the flour blends are made from mill streams of the **SAME WHEAT SOURCE**, Water Holding Capacity alone can be predictive of rheology and baking performance.

- When the flour blends are made from flours of **DIFFERENT WHEAT SOURCES**, all diagnostic solvents must be compared by the Swelling Test assays.

- Sodium carbonate is the most predictive solvent for measuring flours with variable amounts of damaged starch.
Lactic acid is the most predictive solvent for measuring variable gluten quality due to differences in the Glutenin elastic proteins.

Sucrose is the most predictive solvent for measuring Pentosan variations in flours.

Damaged starch and the water-extractable Pentosans are extremely DETRIMENTAL to cookie and cracker baking; but they are beneficial to bread baking, because of their high water absorbing ability.
Flour Functionality = PATTERN of SRC Values

**SRC Behavior Patterns**

- Serve as a fingerprint
- Predict end-product performance
- Recommend to satisfy end-use requirements
As protein decreases, cookie spread increases
As protein decreases, cookie spread also decreases.
SRC Based Behavior

100% U.S. Soft White (SW) Flour - Standard
SRC Lactic Acid Value - 92
Protein Level - 10.8% (Dry Basis)

100% Australia Standard White (ASW)
SRC Lactic Acid Value - 121
Protein Level - 10.33% (Dry Basis)

Protein does not count, SRC Lactic Acid Value does
COOKIES SPREAD TEST

Cookie Diameter: 8.6 cm
Top Grain Score: 4.0
SRC Lactic Acid: 96%
SRC Na2CO3: 93%
Flour Protein: 9.4%

Cookie Diameter: 8.2 cm
Top Grain Score: 1.5
SRC Lactic Acid: 107%
SRC Na2CO3: 85%
Flour Protein: 9.8%

Cookie Diameter: 8.2 cm
Top Grain Score: 0.0
SRC Lactic Acid: 118%
SRC Na2CO3: 84%
Flour Protein: 11.4%

Cookie Diameter: 8.4 cm
Top Grain Score: 3.0
SRC Lactic Acid: 111%
SRC Na2CO3: 83%
Flour Protein: 10.3%

Cookie Diameter: 8.8 cm
Top Grain Score: 5.0
SRC Lactic Acid: 80%
SRC Na2CO3: 78%
Flour Protein: 10.0%
So – how to use SRC in your mill?
SRC Reference Guide – soft wheat products

Absorption: 100% Distilled Water
Pentosan: 50% Sucrose Solution
Damage Starch: 5% Sodium Carbonate Solution
Glutenin: 5% Lactic Acid Solution

<table>
<thead>
<tr>
<th>Type of SRC Solvents</th>
<th>Weight of Solvent @ 14% Moisture Basis</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Cracker Flour</td>
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<tr>
<td>100% Water</td>
<td>50 to 70</td>
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<tr>
<td>50% Sucrose</td>
<td>80 to 110</td>
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<tr>
<td>5% Sodium Carbonate (pH 11)</td>
<td>60 to 85</td>
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<tr>
<td>5% Lactic Acid (pH 2)</td>
<td>100 to 120</td>
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</table>

SRC values for Water, Sucrose, and Sodium Carbonate solvents are preferred to be at the lower end of the range listed in the table for weakness.

SRC value of Lactic Acid solvent in return requires slightly at the higher end of the range in the table to provide some strength to the end products.
## SRC Reference Guide – Hard Wheat Flour

### Type of SRC Solvents

<table>
<thead>
<tr>
<th>Type of SRC Solvents</th>
<th>Weight of Solvent @ 14% Moisture Basis</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Bakers Flour Range</td>
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<tr>
<td>100% Water</td>
<td>65-70</td>
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<tr>
<td>50% Sucrose</td>
<td>105-115</td>
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<tr>
<td>5% Sodium Carbonate (pH 11)</td>
<td>80-90</td>
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<tr>
<td>5% Lactic Acid (pH 2)</td>
<td>&gt;140</td>
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<tr>
<td>Gluten Performance Index (GPI)</td>
<td>0.75</td>
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</table>

### Source Solvents

- **Absorption:** 100% Distilled Water
- **Pentosan:** 50% Sucrose Solution
- **Damage Starch:** 5% Sodium Carbonate Solution
- **Glutenin:** 5% Lactic Acid Solution

### Additional Note

- Gluten Performance Index (GPI) = 0.75
PART 2 – a real world implementation of SRC.

<table>
<thead>
<tr>
<th></th>
<th>Protein As is</th>
<th>SRC Water</th>
<th>SRC Sucrose</th>
<th>SRC Lactic Acid</th>
<th>SRC Na2CO3</th>
<th>Gluten performance Index</th>
<th>Water Absorption</th>
<th>Dev. Time</th>
<th>Stability</th>
<th>Dept. Time</th>
<th>MTI</th>
<th>Height NW (cm)</th>
<th>Height LW (cm)</th>
<th>Volume NW (cc)</th>
<th>Volume LW (cc)</th>
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<td>Gluten performance Index</td>
<td>-0.083</td>
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<td>-0.645</td>
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<td>Water Absorption</td>
<td>0.139</td>
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<td>Dev. Time</td>
<td>0.116</td>
<td>-0.608</td>
<td>-0.471</td>
<td>0.518</td>
<td>-0.580</td>
<td>0.707</td>
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<td>Stability</td>
<td>0.027</td>
<td>-0.777</td>
<td>-0.668</td>
<td>0.421</td>
<td>-0.773</td>
<td>0.755</td>
<td>-0.805</td>
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<td>Dept. Time</td>
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<td>-0.648</td>
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<td>0.555</td>
<td>0.403</td>
<td>-0.447</td>
<td>0.559</td>
<td>-0.609</td>
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<td>-0.549</td>
<td>-0.864</td>
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<td>Height NW (cm)</td>
<td>-0.179</td>
<td>-0.552</td>
<td>-0.460</td>
<td>0.643</td>
<td>-0.620</td>
<td><strong>0.778</strong></td>
<td>-0.709</td>
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<td>0.623</td>
<td>0.625</td>
<td>-0.609</td>
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<td>Height LW (cm)</td>
<td>-0.261</td>
<td>-0.567</td>
<td>-0.447</td>
<td>0.699</td>
<td>-0.620</td>
<td><strong>0.813</strong></td>
<td>-0.739</td>
<td>0.538</td>
<td>0.647</td>
<td>0.643</td>
<td>-0.636</td>
<td>0.970</td>
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<td>Volume NW (cc)</td>
<td>-0.136</td>
<td>-0.585</td>
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<td>0.997</td>
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<tr>
<td>Reduction stages</td>
<td>Yield in %</td>
<td>Moisture (%)</td>
<td>Ash db (%)</td>
<td>Water</td>
<td>Sucrose</td>
<td>Lactic Acid</td>
<td>Na$_2$CO$_3$</td>
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<tr>
<td>C3A G (I)</td>
<td>8.44</td>
<td>13.08</td>
<td>0.35</td>
<td>74.73</td>
<td>121.83</td>
<td>173.20</td>
<td>103.23</td>
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<td>C1/2A F (I)</td>
<td>4.86</td>
<td>14.80</td>
<td>0.38</td>
<td>71.19</td>
<td>117.62</td>
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<td>C3A H (I)</td>
<td>4.71</td>
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<td>C5 H (I)</td>
<td>4.25</td>
<td>13.32</td>
<td>0.43</td>
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<td>C5 G (I)</td>
<td>4.57</td>
<td>13.44</td>
<td>0.44</td>
<td>71.28</td>
<td>124.54</td>
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<tr>
<td>C3 B (II)</td>
<td>1.76</td>
<td>14.00</td>
<td>0.44</td>
<td>63.60</td>
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Cumulative Lactic Acid % (at 14 m.b.)

- Accumulated Lactic Acid % (at 14 m.b.)

Cumulative Extraction vs. Cumulative Lactic Acid at 14% MB
## Can I make this type of flour?

<table>
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<tr>
<th>Type of SRC Solvents</th>
<th>Weight of Solvent @ 14% Moisture Basis</th>
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<td>Bakers Flour Range</td>
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<tr>
<td>100% Water</td>
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<tr>
<td>50% Sucrose</td>
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<tr>
<td>5% Sodium Carbonate (pH 11)</td>
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<td>5% Lactic Acid (pH 2)</td>
<td>&gt;140</td>
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<tr>
<td>Gluten Performance index</td>
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</table>
This portion is usable for the flour type specified

Going to be expensive!!

This is not

have to find a home for this 47%

30% of our extraction
Usable Range
Cumulative Gluten Performance Index

0.75 GPI not possible with these wheats.
Conclusions

1. The type of flour specified cannot be made with and streams of the type of wheat we had on the mill!

2. If we were able to make the GPI, then the flour price would be very high due to only 30% extraction.

3. Better to find this out before we supply the customer than afterwards!

Back to the drawing board!
Knowing these will enable you to optimize each of your flour types, your production divide and/or base flours used in blending.
This means giving the customer what he or she values most!
Further Reading

OPTIMIZING WHEAT BLENDS FOR CUSTOMER VALUE CREATION: A SPECIAL CASE OF SOLVENT RETENTION CAPACITY
by NIKOLAS C HAAS
B.S., Kansas State University, 2006
Thank You for your valued business, and for your attention today.
We wish you every success for the future!