Sourdough Basics

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R&D Manager – Sourdough & Grains
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2 – Sourdough microflora
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What is a Sourdough?
What is Sourdough?

A natural leavening agent
Sourdough offers a natural form of leavening that enhances the taste and nutritional value of baked bread products.

Micro-organisms within the sourdough use the starch and minerals found in flour to ferment and increase the volume of bread, while organic molecules create the flavors.
Preferments for breads with unique flavors

Pre-ferments benefits for consumers & bakers

**Bio-chemical**
- Leavening
- Acidification

**Rheological**
- Extensibility
- Machinability

**Nutrition**
- Eg GI lowering
- Starch digestibility

**Finished Bread**
- Healthy image
- Diversity & tradition

**TASTE**
- Texture

Preferment → Ingredients mixing → Bulk proof → Divide & Make up → Final proof → Bake → Cool & Pack
What do you need to make a Sourdough?

- Flour
- Water
- Yeast
- Time
- Temperature
- Alcohols
- CO2
- Lactic acid
- Acetic acid
Where to find the magic ingredient?

- A portion of luck
- Yeast water
- Live bacteria from yogurt, beer, ...
Traditional Sourdough Process
2- Sourdough Microflora

- Yeast
- Lactic acid bacteria
- Starch granule
- Gluten network
Evolution microflora over time in the mother dough

**Numbers of cells***

- **Total microflora**
- **Lactic acid bacteria**
- **Aerobic bacteria**
- **‘Wild’ yeast**

*Survey of HOCHSTRASSER & coll published in Handuch Sauerteig 2006*
Ecosystem and associations

Microbial ecosystem of sourdough is based on a symbiotic relationship

- Mainly due to the metabolic versatility of each organism
- Eg. Lactobacillus sanfranciscensis consumes maltose (favorite food)
- Eg. Candida Milleri yeast consumes fructose, glucose and galactose
- Yeast/LAB = 1/50 to 1/100

- **Lactic Acid Bacteria**
  - 1.10^9 CFU/g of sourdough
  - Lactobacillus
  - Leuconostoc
  - Pediococcus
  - Weissella
  - Lactococcus

- **Yeast**
  - 1.10^7 CFU/g of sourdough
  - Saccharomyces
  - Candida
  - Kazachstania
  - Torulaspora
  - Pichia
Biodiversity in different sourdoughs

**Sourdough n°55**
- **Lb sanfranciscencis**

**Sourdough n°69**
- **Lb sanfranciscensis**
- **Lb plantarum**
- **Lb fermentum**

**Sourdough n°25**
- **Lb plantarum**
- **Lb curvatus**
- **Lactococcus lactis**
- **Lc mesenteroides**

Sourdough library project, 2010-2015
3 – Sourdough Biochemistry

What is happening in the sourdough?
Figure 2: Evolution of LAB population, pH & acidity during sourdough fermentation
Biochemical Mechanism - Yeast

Carbohydrate Fermentation by YEAST

starch & free sugars + Ethanol

Alcoholic fermentation

CO2

Aromatic compounds
Biochemical Mechanism – By LAB

Carbohydrate fermentation by LA Bacteria: ACIDITY

Starch & free sugars + Lactic fermentation → lactic acid, CO2, acetic acid
Biochemical Mechanism

Protein degradation by Bacteria & YEAST

Gluten + amino acids → Superior alcohols, Aldehydes
Protein Degradation by Bacteria & Yeast

Protein (gluten...) $\Rightarrow$ Amino-acids $\Rightarrow$ aldehydes & higher alcohols

Figure 3: Amino acids repartition in flour, LAB sourdough and Sponge (B.Onno, 2004)
4 - Parameters that can affect flavor

<table>
<thead>
<tr>
<th>Internal Factors</th>
<th>External (Process)</th>
</tr>
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<tbody>
<tr>
<td>Carbohydrates</td>
<td>Temperature</td>
</tr>
<tr>
<td>Amino Acids</td>
<td>Dough Yield</td>
</tr>
<tr>
<td>Minerals</td>
<td>Fermentation Time</td>
</tr>
<tr>
<td>Lipids - Free Fatty Acids</td>
<td>Oxygen</td>
</tr>
<tr>
<td>Enzymes Activities</td>
<td></td>
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</tbody>
</table>
Influence of Time

- Time is one of the most important factors in determining bread’s flavor
- Time contributes to level of accumulated organic acids, amino acids, pH and TTA
- pH can decrease very fast and stabilize within 24-72 hours but TTA can continue to increase throughout the whole fermentation
Influence of time and temperature on acid production

![Graph showing acid production over time for different temperatures (65F, 77F, 95F, 110F).]

<table>
<thead>
<tr>
<th>Time (hrs)</th>
<th>65F</th>
<th>77F</th>
<th>95F</th>
<th>110F</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>2.45</td>
<td>3.22</td>
<td>5.36</td>
<td>3.7</td>
</tr>
<tr>
<td>12</td>
<td>3.36</td>
<td>6.42</td>
<td>6.18</td>
<td>5.11</td>
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<tr>
<td>24</td>
<td>6.15</td>
<td>8.59</td>
<td>12.03</td>
<td>8.27</td>
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<tr>
<td>48</td>
<td>9.32</td>
<td>12.8</td>
<td>16.8</td>
<td>12.99</td>
</tr>
<tr>
<td>72</td>
<td>11.22</td>
<td>15.25</td>
<td>18.14</td>
<td>13.51</td>
</tr>
</tbody>
</table>
Flour - Composition

<table>
<thead>
<tr>
<th></th>
<th>High Gluten</th>
<th>Low Gluten</th>
<th>Whole Wheat</th>
<th>Rye</th>
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</thead>
<tbody>
<tr>
<td>Moisture%</td>
<td>14</td>
<td>10-12</td>
<td>14</td>
<td>13.5</td>
</tr>
<tr>
<td>Ash</td>
<td>0.56</td>
<td>0.34-0.38</td>
<td>1.6</td>
<td>1.05-1.45</td>
</tr>
<tr>
<td>Protein</td>
<td>13.5-14.5</td>
<td>6.5-8.5</td>
<td>14</td>
<td>7.6-11.6</td>
</tr>
</tbody>
</table>

- Flour composition plays a significant role in acid production
  - Low protein flour is a low extraction flour thus less ash
  - Ash in flour contains minerals that act as buffers, longer fermentation due to controlled pH
Flour Type

Acid Production vs Flour

TTA (ml NaOH/g)

<table>
<thead>
<tr>
<th>Flour Type</th>
<th>L. Brevis</th>
<th>L. Plantarum</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Gluten (Dominator)</td>
<td>12.59</td>
<td>13.26</td>
</tr>
<tr>
<td>Low Gluten (Cake)</td>
<td>8.92</td>
<td>10.41</td>
</tr>
<tr>
<td>Whole Wheat</td>
<td>17.33</td>
<td>19.18</td>
</tr>
<tr>
<td>Rye</td>
<td>21.06</td>
<td>21.67</td>
</tr>
</tbody>
</table>
Effect of Temperature on flavor

Acid Production Over Time

Time (Hours)

Acid (NaOH mL/g)

65F
77F
95F
110F
% Solids vs Acid Production

Acid Production vs % Solids

<table>
<thead>
<tr>
<th>Solids</th>
<th>L. Brevis</th>
<th>L. Plantarum</th>
</tr>
</thead>
<tbody>
<tr>
<td>20%</td>
<td>9.61</td>
<td>11.35</td>
</tr>
<tr>
<td>30%</td>
<td>13.33</td>
<td>14.09</td>
</tr>
<tr>
<td>40%</td>
<td>15.31</td>
<td>15.39</td>
</tr>
<tr>
<td>50%</td>
<td>16.72</td>
<td>16.14</td>
</tr>
<tr>
<td>60%</td>
<td>17.34</td>
<td>17.58</td>
</tr>
</tbody>
</table>
Lactic Acid fermentation by the bacteria

Impact on the organic acids production

- Temperature
- Solids

Temperature

68-77°F

86-95°F

Solids

Firm sourdough

Liquid sourdough

Acetic acid

Lactic acid
Consistency - How to control the key parameters

• Define flour specs: protein, ash level, falling number

• Recipe checks and recording

• Follow thoroughly & record fermentation times and temperatures

• Measure and record the results: pH, TTA, flavor

• Training: regular training on the importance of the key parameters, hygiene and risks of contamination, line cleans

• Select your most disciplined people for the job
Thank You

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