DEVELOPING A COMMON LANGUAGE TO DESCRIBE THE ATTRIBUTES OF BAKED GOODS

RICHARD LEOUCHER

PAUL BARNES

Puratos

Reliable partners in innovation

HunterLab

The world’s true measure of color
AGENDA

• Texture
  – How to describe texture? Tools and Methods
  – How to develop the right texture: “What is your Texture?”

• Flavor
  – How to describe the flavor of bread? Tools and Methods
  – How to develop the right flavor profile: “What is your Flavor?”
FRESHNESS & TASTE: THE MOST IMPORTANT ATTRIBUTES OF BREADS

Consumer Survey Study, Puratos US
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HOW TO DESCRIBE TEXTURE?

Texture *noun* : the way something feels when touched, eaten

Fresh, soft, staled, spongy, humid, doughy, ...
<table>
<thead>
<tr>
<th><strong>Sensory</strong></th>
<th><strong>Instrumental</strong></th>
<th><strong>Vocabulary</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Softness</strong></td>
<td>Force required to compress the bread with hands, between the molars, or between tongue and palate</td>
<td>Force required to compress the bread crumb or the complete baked product till certain deformation</td>
</tr>
<tr>
<td><strong>Resilience of baked product</strong></td>
<td>Speed and degree (springiness) at which the baked product returns to its original shape after deformation</td>
<td>Percentage of the deformation energy used by the baked product to partially return to its original shape</td>
</tr>
<tr>
<td><strong>Resilience of the crumb</strong></td>
<td>Speed and degree (springiness) at which the crumb returns to its original shape after deformation</td>
<td>Force used by the crumb after 20 seconds with certain deformation</td>
</tr>
<tr>
<td><strong>Cohesiveness</strong></td>
<td>Degree to which the baked crumb holds together when rubbing or folding, crumbliness</td>
<td>Ratio between &quot;energy&quot; of the second bite to &quot;energy&quot; of the first bite,</td>
</tr>
<tr>
<td><strong>Moistness</strong></td>
<td>Moist or cold feeling with fingers, hands, lips, palate ad month of the baked product (crumb and crust), adherence of the crumb to the fingers and more to the palate upon chewing (stickiness)</td>
<td>Aw, % H₂O, NMR, not always effective; force to loosen probe from product surface after applying a fixed deformation</td>
</tr>
<tr>
<td><strong>Short bite</strong></td>
<td>Reflects the force to break a sample and the force to masticate to a consistency ready to swallowing</td>
<td>Work necessary to break the bread in two pieces</td>
</tr>
<tr>
<td><strong>Melting</strong></td>
<td>Reflects the time and the easiness a bolus of bread can be swallowed. Favored by sufficient initial moistness followed by short bite</td>
<td>NA</td>
</tr>
<tr>
<td>Score</td>
<td>Softness</td>
<td>Resilience</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>++++</td>
<td>Extremely soft, no</td>
<td>Speed=4</td>
</tr>
<tr>
<td></td>
<td>resistance</td>
<td>No deformation</td>
</tr>
<tr>
<td>+++++</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+++</td>
<td>Very soft</td>
<td>Speed=3</td>
</tr>
<tr>
<td></td>
<td>Very soft</td>
<td>No deformation</td>
</tr>
<tr>
<td>+</td>
<td>Soft</td>
<td>Speed=2</td>
</tr>
<tr>
<td></td>
<td>Slight soft</td>
<td>No deformation</td>
</tr>
<tr>
<td>+</td>
<td>Slight soft</td>
<td>Speed=1</td>
</tr>
<tr>
<td></td>
<td>Slight soft</td>
<td>Slight deformation remains</td>
</tr>
<tr>
<td>+</td>
<td>Slight soft</td>
<td>Speed=1</td>
</tr>
<tr>
<td></td>
<td>Slight soft</td>
<td>Slight deformation remains</td>
</tr>
<tr>
<td>+</td>
<td>As reference</td>
<td>Speed=1</td>
</tr>
<tr>
<td></td>
<td>As reference</td>
<td>Slight deformation remains</td>
</tr>
<tr>
<td>+</td>
<td>Slight hard</td>
<td>Speed=0</td>
</tr>
<tr>
<td></td>
<td>Slight hard</td>
<td>Big deformation</td>
</tr>
<tr>
<td>-</td>
<td>Hard</td>
<td>Speed=1</td>
</tr>
<tr>
<td>--</td>
<td>Hard</td>
<td>Deformation</td>
</tr>
<tr>
<td>---</td>
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<tr>
<td>----</td>
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<td></td>
</tr>
<tr>
<td>---</td>
<td>Very hard</td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>As a stone</td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>As a stone</td>
<td></td>
</tr>
</tbody>
</table>
### Evaluation Form - AVERAGE SCORE

<table>
<thead>
<tr>
<th>Title:</th>
<th>Pan Bread Texture Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production date:</td>
<td>7/15/2016</td>
</tr>
<tr>
<td>Evaluation Date:</td>
<td>7/27/2016</td>
</tr>
<tr>
<td>Evaluation Day:</td>
<td>D12</td>
</tr>
</tbody>
</table>

#### Scores

<table>
<thead>
<tr>
<th>Texture</th>
<th>Name of test</th>
<th>Reference</th>
<th>Prototype A</th>
<th>Prototype B</th>
<th>Prototype C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Softness</td>
<td></td>
<td>6.5</td>
<td>8.5</td>
<td>7.5</td>
<td>8.5</td>
</tr>
<tr>
<td>Resilience</td>
<td></td>
<td>3.5</td>
<td>2.5</td>
<td>4.5</td>
<td>5.5</td>
</tr>
<tr>
<td>Cohesiveness</td>
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<td>5.5</td>
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<td>5.5</td>
</tr>
<tr>
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<td>5.5</td>
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</tr>
<tr>
<td>Short Bite</td>
<td></td>
<td>5.5</td>
<td>5.5</td>
<td>6.5</td>
<td>6.5</td>
</tr>
<tr>
<td>Melting</td>
<td></td>
<td>6.5</td>
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</tr>
</tbody>
</table>
• How to measure texture?
A combination of:

Analytical measurements

Sensorial Analysis
ANALYTICAL MEASUREMENTS

- **Tools:**
  - Softness
  - Resilience
  - Short bite
TEXTURE MEASUREMENT WITH TEXTURE ANALYZER

• **Firmness**
  - $F_1 =$ force of probe to crumb necessary to obtain the fixed deformation
  - firmness = $F_1$

• **Elasticity**
  - $F_{20s} =$ force of crumb to probe after 20s at fixed deformation
  - elasticity = $F_{20s} / F_1 \times 100 = RR_1$

• **Stickiness**
  - $F_s =$ negative force = force needed to loosen probe from product surface
  - stickiness = $F_s$

---

![Graph showing force vs. time with markers for $F_1$ day 1, $F_{20s}$ day 6, $F_{20s}$ day 1, and $F_s$.]
COMBINING THE RESULTS OF THE 2 METHODS TO CHARACTERIZE THE TEXTURE OF BREADS

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<td>6.5</td>
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<td>6.5</td>
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<td>6.5</td>
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</tbody>
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**Diagram:**

- Force (g) vs. Time (sec.)
- 25% deformation
- F₁ day 1
- F₂₀s day 6
- F₂₀s day 1
- Fₛ
Using the vocabulary and the evaluation methods to develop the right textures
“What’s your Texture?”

- Sensorial
- Instrumental

Axis 1: 72%
- Chewy
- Crumbly
- Dry
- Hard

Axis 2: 18%
- Moist
- Soft
- Claggy/Sticky
- Sticky
- Short bite
- Resilient
**CONSUMER UNDERSTANDING:**
**WHAT TEXTURE IS PREFERRED?**

**Conclusion:** the preferred texture for white bread in San Francisco is characterized by more melting, moist, open but sticky crumb and a minimum of resilience to it. Breads that are dry and crumbly are not go zone. Softness is less of a defining feature.
AGENDA

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  – How to describe the flavor of bread? Tools and Methods
  – How to develop the right flavor profile: "What is your Flavor?"
THE COMPLEXITY OF FLAVOR TERMINOLOGY
## FLAVOR VOCABULARY AND SCORING

<table>
<thead>
<tr>
<th>Score</th>
<th>Sour</th>
<th>Fermented</th>
<th>Roasted</th>
<th>Cereal</th>
<th>Fruity</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Very sour</td>
<td>Strong fermentation flavor</td>
<td>Strong roasted flavor</td>
<td>Strong cereal flavor</td>
<td>Strong fruity flavor</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Sour</td>
<td>Fermented</td>
<td>Roasted flavor</td>
<td>Cereal flavor</td>
<td>Fruity flavor</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Some sour</td>
<td>Some fermentation flavor</td>
<td>Some roasted flavor</td>
<td>Some cereal flavor</td>
<td>Some fruity flavor</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Little sour</td>
<td>Little fermentation flavor</td>
<td>Little roasted flavor</td>
<td>Little cereal flavor</td>
<td>Little fruity flavor</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Not sour at all</td>
<td>No fermentation flavor at all</td>
<td>No roasted flavor at all</td>
<td>No cereal flavor at all</td>
<td>No fruity flavor at all</td>
</tr>
</tbody>
</table>
# Evaluation Form - AVERAGE SCORE

<table>
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<tr>
<th>Title:</th>
<th>San Francisco Sourdough Bread</th>
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<tbody>
<tr>
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<tr>
<td>Evaluation Date:</td>
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</tr>
<tr>
<td>Evaluation Day:</td>
<td>D1</td>
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</tbody>
</table>

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<td>7.5</td>
</tr>
<tr>
<td></td>
<td>Fermented</td>
<td>2.5</td>
<td>2.5</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>Roasted</td>
<td>2.5</td>
<td>3.5</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>Cereal</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Fruity</td>
<td>2.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>
A COMBINATION OF SENSORIAL EVALUATION AND ANALYTICAL MEASUREMENTS

SENSORIAL

- Experts panel
- Consumer panel

ANALYTICAL

- Chromatography
- Mass Spectrometry
IDENTIFICATION OF FLAVOR COMPOUNDS USING GC-MS

Isolation  ➔  Separation  ➔  Detection
**FLAVOR: A COMBINATION OF MANY MOLECULES**

### SENSORIAL
- Experts panel
- Consumer panel

### ANALYTICAL
- Chromatography
- Mass Spectrometry

<table>
<thead>
<tr>
<th>Component</th>
<th>Odour character</th>
<th>Odour threshold value (ppb or µg/l water)</th>
</tr>
</thead>
<tbody>
<tr>
<td>maltol</td>
<td>caramel</td>
<td>35,000</td>
</tr>
<tr>
<td>hexanol</td>
<td>green</td>
<td>700</td>
</tr>
<tr>
<td>vanilline</td>
<td>vanille, sweet</td>
<td>20</td>
</tr>
<tr>
<td>limoneen</td>
<td>citrus</td>
<td>10</td>
</tr>
<tr>
<td>hexanal</td>
<td>grassy, green</td>
<td>4,5</td>
</tr>
<tr>
<td>2-methylbutanal</td>
<td>etherisch, almond</td>
<td>4</td>
</tr>
<tr>
<td>ethyl-2-methylbutanoaat</td>
<td>apple, ripe fruit</td>
<td>0,1</td>
</tr>
<tr>
<td>geosmine</td>
<td>earthy, mouldy</td>
<td>0,01</td>
</tr>
<tr>
<td>2-isobutyl-3-methoxypyrazine</td>
<td>Red pepper</td>
<td>0,002</td>
</tr>
<tr>
<td>2,4,6-trichlooranisol</td>
<td>coark, musty</td>
<td>0,00003</td>
</tr>
</tbody>
</table>
FLAVOR MAPPING “What’s your Flavor?”

- **Yeasty - alcoholic**
- **Fruity**
  - raisin
  - grape
  - dried fruit
- **Cereal**
  - wheat
  - oatmeal
  - hay
- **SOUR**
  - lactic
- **Acetic**
- **Fermented**
  - vinegar
  - lemon juice
- **Roasted**
  - crusty
  - toasted
  - woody

**Sapore**

Yogurt
sauerkraut

IBIE
International Baking Industry Exposition

Puratos
Reliable partners in innovation
FLAVOR ATTRIBUTES: APPLICATIONS

- Multigrains
  - Wholewheat
  - Mild Sourdough
  - Rye breads

- Strong sourdough breads
- Rye breads

- Soft breads & rolls
- Flatbreads/pizza

- Crusty rolls/reheated items
- Flatbreads/pizza

- Artisan breads
- Multigrains
  - Wholewheat

- ROASTED
- CEREAL
- FERMENTED
- FRUITY
- SOUR
- lactic
- acetic
CONCLUSIONS: TEXTURE & FLAVOR

• Essential to develop a common language
  – To understand one another and avoid misunderstandings
  – To speed up the development process

• Value in having mapping tool
  – To better visualize the current situation (texture & flavor)
  – To easily understand the exact goal to achieve

• Use Texture and Flavor to differentiate products
Questions ?

Richard Leboucher
rleboucher@puratos.com

Thank You!
What’s Your Color?
Why Measure the Color of Baked Goods?

• Indicator of overall product quality
• Indicator of process variation
• Helps ensures brand consistency
• Visual methods of specifying color are subjective
• Measuring color using an instrument gives objective results
Applications Challenge

The color of baked products is difficult to measure because:

- Curved surfaces and irregularly shapes
- Color can vary on edges versus center
- Lightness/darkness is often key parameter in consumer acceptance – but color can vary as well
- Current color measurement techniques do not always reproduce how eye sees color
Challenges
Traditional Methods

Color is typically evaluated by:

1. Visual assessment
2. Simple Colorimeter
3. Camera / defect monitor
Where is Color Typically Measured?

• Incoming QC of raw materials
• In-process inspection
• QC finished product
• Color is measured:
  ✓ In the lab
  ✓ At the line
  ✓ On the line
How is Color Described and Communicated in Baked Products?
Baking Contrast Units (BCU)

Baking Contrast scale:

- Quantifies lightness of baked, crust, crumb and similar applications
- Helps eliminate the human subjectivity
- BCU can be applied to monitor browning in any baked product
Baking Contrast Units (BCU)

BCU = \log \left( \frac{Y}{2.5} \right)

- \( Y \) = CIE Tristimulus Y value
- The BCU range ranges from 0.00 BCU (darkest) to 5.25 BCU (lightest)
- A difference of 0.1 BCU units is estimated to be a visual difference
How is Color Also Described, Communicated?

- Tristimulus color scales
  - Not by words, but numbers, specifications, and tolerances
- Tristimulus scales describe:
  - Lightness/Darkness
  - Hue
  - Chroma
**Tristimulus Color Scales**

- The most widely used color scale is L,a,b
  - Hunter L,a,b
  - CIE L,a,b (L*a*b*)
- Color difference scale most widely used is
  - Delta E
L,a,b Color Space

L = 100

L = 0
Where did the L,a,b scale originate?
The Human Eye

- Lens
- Cornea
- Optic Nerve
- Macula
- Retina
- Fovea
- Rods
- Green Cones
- Red Cones
- Blue Cones
L, a, b Color Space
Tristimulus Color on a Bread Product

L* = 71.68

a* = 1.77

b* = 8.55
Color Measurement 101

To See Color

Light Source
Object
Observer

To Measure Color

Light Source
Baked Product
Spectrometer
Measuring Color - Spectrophotometer

- Light Source
- Specimen
- Diffraction Grating
- Diode Array
- Data Display
- Data Processor

L = 41.9
a = 37.7
b = 8.6
The color of baked products is difficult to measure because:

- Curved surfaces and irregularly shapes
- Color can vary on edges versus center
- Lightness/darkness is often key parameter in consumer acceptance – but color can vary as well
- Current color measurement techniques do not always reproduce how eye sees color
Best Practices - Application

- Illuminate the product circumferentially
- Average 2-4 measurements
- Measure large sample area
- Sealed optics to prevent contaminants
- Bench-top or portable technology
Establishing a Specification / Best Practices

There are two levels of color difference:

- **Minimum perceptible difference** – can you see any difference?
- **Maximum acceptable difference** – is the difference too significant?

Most baking manufacturers are concerned about the **maximum acceptable difference**
Establishing a Specification / Best Practices

- Each product family should have its own standard and target specification
- Each product family should have its own tolerances
- Tolerances can/should be different for each product
Establishing a Specification / Best Practices

- **YOU** define the color quality relationship
- The measurement system
  - Customer acceptance parameters
  - Raw material inspection
  - Process variables and variation
  - Business considerations
- Internal systems may be tighter
Establishing a Specification / Best Practices

• Choose samples that are representative of the product and manufacturing
• Prepare samples the same way each time
• Present the samples to the instrument in a repeatable manner
• Make multiple preparations of the sample and average measurements
Thanks

For additional information:

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Web site: www.hunterlab.com