Flavor Pairing
Sensory science to drive value added processing
Gabriela Sanchez Brambila Ph.D.
“Sensory Science is a cross-disciplinary scientific field dealing with the way humans perceive the world and act upon sensory input. It addresses how sensory systems function, from stimulation and perception to cognition and behavior. Sensory food research aims to reach a better understanding of how the senses react during food intake, but also how our senses can be used in quality control and product design.”
Analytical Profiling QDA

Consumer Difference Discrimination Acceptance

• Consumers liking
  • Difference detection
    • Reformulation/R&D
      • Quality Control
        • Product understanding
          • Sensory profiling
The Big Picture:
*Chemistry and Flavor in the sense of food*
Analysis of Texture, protein composition and tenderization of commercial Mollusks

- AA quality
  - *H. fulgens* 
    - Blue Abalone
- Texture problem
  - *H. cracherodii* 
    - Black Abalone
- Texture problem
  - *Astraea undosa* 
    - Conch

Enzymatic treatment using papain
Characterization of flavor in marine species
Jumbo squid, Dosidicus gigas

• Sensory panel developed a flavor profile for squid meat

• The off flavor was characterized by bitterness and sourness, and two after taste/feel attributes, metallic and astringency.

• The off-flavor intensity was related to the size of the organism. Significant difference of the off flavor – compound concentration between small (55 ML) and large (85 ML) organisms.

• The off flavor is an amine compound, of chemical hydrophobic/aromatic character, low MW (<1000 Da), present in the soluble fraction of the muscle.

• Application: squid mantle made into steak, tenderized and marinated for masking flavor to those markets where bitter -sour taste is not accepted.

• The Norm for QC were reviewed and modified accordingly to squid meat
Sensory Flavor Profile for Mollusks Species

<table>
<thead>
<tr>
<th>Term</th>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Springiness</td>
<td>Sprin</td>
<td>Degree to which a sample returns to its original shape after partial compression with the molar teeth.</td>
</tr>
<tr>
<td>Cohesiveness</td>
<td>Coh</td>
<td>Degree to which a sample deforms rather than crumbles, cracks, or breaks—one compression with molar teeth.</td>
</tr>
<tr>
<td>Hardness</td>
<td>Hard</td>
<td>Force to compress the sample one bite with molar teeth.</td>
</tr>
<tr>
<td>Chewiness</td>
<td>Chew</td>
<td>Amount of work to chew the sample to get it ready to swallow.</td>
</tr>
<tr>
<td>Flavor</td>
<td></td>
<td>Aromatic characteristic of ocean air, salt water, pickling salts.</td>
</tr>
<tr>
<td>Briny</td>
<td>Briny</td>
<td>Aromatic associated with decaying vegetation, particularly old seaweed, decaying wood, and swamp grass</td>
</tr>
<tr>
<td>Decaying</td>
<td>Dec-Veg</td>
<td>Aromatic associated with decaying vegetation, particularly old seaweed, decaying wood, and swamp grass</td>
</tr>
<tr>
<td>Vegetable</td>
<td></td>
<td>A flat chemical feeling factor stimulated on the tongue by metal coins.</td>
</tr>
<tr>
<td>Metallic</td>
<td>Metal</td>
<td>The slightly sweet aromatic associated with crab, lobster, and shrimp.</td>
</tr>
<tr>
<td>Crustacean</td>
<td>Crust</td>
<td>Aromatic associated with cooked fish.</td>
</tr>
<tr>
<td>Fishy</td>
<td>Fishy</td>
<td>Aromatic associated with slightly oxidized fats and oils, reminiscent of wet cardboard packaging.</td>
</tr>
<tr>
<td>Cardboardy</td>
<td>Cardbd</td>
<td>Aromatic associated with slightly oxidized fats and oils, reminiscent of wet cardboard packaging.</td>
</tr>
<tr>
<td>Basic taste</td>
<td></td>
<td>Taste on the tongue stimulated by sugars and high potency sweeteners.</td>
</tr>
<tr>
<td>Sweet</td>
<td>Sweet</td>
<td>Taste on the tongue stimulated by sodium salt, especially sodium chloride.</td>
</tr>
<tr>
<td>Salty</td>
<td>Salt</td>
<td>Basic taste on the tongue stimulated by acids.</td>
</tr>
<tr>
<td>Sour</td>
<td>Sour</td>
<td>Taste on the tongue stimulated by solutions of caffeine, quinine, and certain other alkaloids.</td>
</tr>
<tr>
<td>Bitter</td>
<td>Bitter</td>
<td>A flat chemical feeling factor stimulated on the tongue by metal coins.</td>
</tr>
<tr>
<td>Aftertaste/afterfeel</td>
<td></td>
<td>The chemical feeling factor on the tongue or other skin surfaces of the oral cavity described as puckering/dry and associated with tannins or alum.</td>
</tr>
<tr>
<td>Metallic</td>
<td>Aft-met</td>
<td>An overall term for the aroma and flavor note reminiscent of vegetable oil for mineral oil products.</td>
</tr>
<tr>
<td>Astringent</td>
<td>Aft-astr</td>
<td>Coating on lining of mouth associated with cooked rice, pasta, oatmeal.</td>
</tr>
</tbody>
</table>

Sensory profile for abalone including 7 flavor attributes, 4 aftertastes and Basic tastes and basic texture attributes.
Table 10. Correlation matrix\textsuperscript{a} between the sensory texture attributes and instrumental texture measurements of abalone.

<table>
<thead>
<tr>
<th></th>
<th>A-har TPA</th>
<th>A-cho TPA</th>
<th>A-spr TPA</th>
<th>A-cep TPA</th>
<th>B-har TPA</th>
<th>B-cho TPA</th>
<th>B-spr TPA</th>
<th>B-cep TPA</th>
<th>A-she WB</th>
<th>B-she WB</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-spr S</td>
<td>0.32</td>
<td>0.33</td>
<td>-0.22</td>
<td>0.34</td>
<td>0.16</td>
<td>0.26</td>
<td>-0.07</td>
<td>0.23</td>
<td>0.37</td>
<td>0.16</td>
</tr>
<tr>
<td>A-coh S</td>
<td>0.58</td>
<td>0.32</td>
<td>-0.15</td>
<td>0.58</td>
<td>0.36</td>
<td>0.25</td>
<td>0.23</td>
<td>0.45</td>
<td>0.52</td>
<td>0.23</td>
</tr>
<tr>
<td>A-har S</td>
<td>0.69*</td>
<td>0.43</td>
<td>0.03</td>
<td>0.74*</td>
<td>0.49</td>
<td>0.32</td>
<td>0.34</td>
<td>0.60*</td>
<td>0.64*</td>
<td>0.41</td>
</tr>
<tr>
<td>A-cep S</td>
<td>0.73*</td>
<td>0.20</td>
<td>-0.07</td>
<td>0.69*</td>
<td>0.60</td>
<td>0.25</td>
<td>0.34</td>
<td>0.34</td>
<td>0.63*</td>
<td>0.43</td>
</tr>
<tr>
<td>B-spr S</td>
<td>0.45</td>
<td>0.46</td>
<td>0.38</td>
<td>0.57</td>
<td>0.13</td>
<td>0.31</td>
<td>-0.10</td>
<td>0.20</td>
<td>0.15</td>
<td>0.05</td>
</tr>
<tr>
<td>B-coh S</td>
<td>0.61*</td>
<td>0.02</td>
<td>0.02</td>
<td>0.54</td>
<td>0.54</td>
<td>0.31</td>
<td>0.1</td>
<td>0.59</td>
<td>0.56</td>
<td>0.60*</td>
</tr>
<tr>
<td>B-har S</td>
<td>0.75*</td>
<td>0.29</td>
<td>0.23</td>
<td>0.79*</td>
<td>0.65</td>
<td>0.27</td>
<td>0.13</td>
<td>0.72*</td>
<td>0.65*</td>
<td>0.57</td>
</tr>
<tr>
<td>B-cep S</td>
<td>0.79*</td>
<td>0.27</td>
<td>0.16</td>
<td>0.80*</td>
<td>0.62*</td>
<td>0.36</td>
<td>0.27</td>
<td>0.73*</td>
<td>0.73*</td>
<td>0.57</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Abbreviation as in Table 9.

* Numbers are correlation coefficients greater than $r=0.60$; $n=3$

S denotes the sensory panel evaluation.
TPA denotes the instrumental variables from Texture profile analysis.
WB denotes the shear value from Warner-Bratzler device.
To keep in mind:

**Sensory Science:**
study of the subjects perception, measure and evaluation...

**Sensory Evaluation:**
Measure, methodology to interpret and analyze the sensory responses

**Sensory Quality:**
Evaluation of the organoleptic aspect of food

**Flavor pairing:**
Is the matching of food and ingredients that have a good flavor impact
Flavor pairing: combination of food and ingredients that will show a favorable effect in their overall flavor.
Hypothesis: foods that share similar compounds taste better when they are together.

4 methyl pentatonic
Flavor Network

When the world meets America...
When the world meets America

- Chocolate
- Vanilla
- Sugar
- Cheese
Culture, tradition, exposure, flavor match...

Do combinations transcend individual and cultures?
Local and regional pairing

DALE EARNHARDT JR'S BANANA-MAYO SANDWICH
What makes a Good Pairing?

• Presence of similar compounds
• Individual flavor exposure
• Balance of basic tastes and flavor aromatics
• Anthropology/culture
Descriptive Analysis in Milk Chocolate

Aromatics
- Caramelized
- Vanilla/Vanillin
- Chocolate Essence
- Dairy
- Malty

Basic Tastes
- Sweet
- Salt
- Sweet
Nut & Chocolate: Descriptive Analysis of pairing

Natural Almond

- No Chocolate Essence
- Brown Fruit
- Increase Cherry
- Decrease in Dairy (NFDM & Soured milk/cheesy)
- Increase in Oaky/Woody

Milk Chocolate

- Sweet
- Sour
- Lower Bitter

Feeling Factors

- Decrease Astringent

High Balance & Blend
Nut & Cheese

Unsalted Almond

White Cheddar Cheese

Aromatics

Brown Fruit

Basic Tastes

Increase in Bitter

Feeling Factors

Astringent

Increase in Oaky/Woody

No Raspberry

No Vanilla

High Balance & Blend
What drives good sensory quality?

- Innovation
- Concept development
- Fusion cuisine trend - demand

Consumer satisfaction

Marketing

• Local
  • Regional
  • International

Flavor pairing can be used to improve sensory quality
Sensory Spectrum approach to Investigate good flavor combinations under the pairing scheme

• Objective: to develop a rapid methodology for exploring flavor pairing of product category.
• Using Expert Panels to Identify and Describe Successful Flavor Combinations

Fresh Navel Orange  |  Bitter Orange Marmalade  |  Dried Orange Peel
Method

Intro & Ingredient Exploration
- process concepts presented to expert tasters or panelists
- Panelists are divided into groups (3-4)
- Panelists are asked to familiarize with ingredients.

Create & Test – Single Ingredient
- Each group use one category (e.g. “herbs”).
- Strive for quantity
- Panelists/groups judge combinations success and reason for success.

Debrief - Findings and Next Steps
- Highlights main findings
- Suggests exploration strategies for the next section of the session.

Create & Test – Multi Ingredient
- Each group is use second category.
- Participants combine flavors, record and taste combinations based on observation from first sessions.
- Strive for quantity
- Focus on multi-ingredients mostly.
- Individuals/group critique combinations.

Debrief – Themes To Explore
- Participants review notes/findings and:
  - Highlight themes and trends
  - Suggest possible venues of explorations for product development.
3 Focus ingredients + 140 combining ingredients

Focus Ingredients

- Fresh Navel Orange
  - Sensory Highlights:
    - Raw Citrus
    - Light Floral
    - Light Green / Fresh

- Bitter Orange Marmalade
  - Sensory Highlights:
    - Cooked Citrus
    - Caramelized
    - Light Tropical / Floral

- Dried Orange Peel
  - Sensory Highlights:
    - Cooked Citrus
    - Terpene
    - Slightly woody

Combination Ingredients

- Fruits & Vegetables (n=45)
- Spices, Herbs & Seasonings (n=57)
- Nuts, Sweet Aromatics & Chocolate (n=22)
- Dairy & Meat (n=16)
<table>
<thead>
<tr>
<th></th>
<th>High Success</th>
<th>Moderate Success</th>
<th>Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Synergistic</strong></td>
<td>High balance and blend. Complementarity of aromas. Results either in a tightly balanced flavor/fragrance or in a concept emphasizing one of the characteristics of the focus ingredient.</td>
<td>Moderate balance and blend. Aromas complement one another but there is a missing character or the aromas are slightly off balance.</td>
<td>Low balance and blend of flavors. Flavors are discordant with little commonalities among the flavor components.</td>
</tr>
<tr>
<td><strong>Contrast</strong></td>
<td>Flavors combinations create an interesting contrast. Some underlying commonalities but the contrasting ingredient offer a unique characteristics not present in the focus ingredient</td>
<td>Flavors create a moderate contrast. Some underlying commonalities, but a flavor may be missing- to result in success</td>
<td>Flavors contrast but are discordant</td>
</tr>
<tr>
<td><strong>Combinations</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Food and beverage pairings: a sensory approach to a culinary phenomenon (Lee, L.; Lawless, L.; Oftedal, K.; Koelliker, Y.; Civille, G.V.; Pangborn Symposium, 2013)
120-min session with 10 expert panelists yield 232 tested combinations

**Single vs. Multi-Ingredient Combinations**
- 158 combinations = orange + single ingredient (68%)
- 74 combinations = orange + multi-ingredient (32%)

**Success**
- 116 combinations (50%) = success
- 43 combinations (19%) = moderate success
- 73 combinations (31%) = failure
Sensory Science is the link between soft science with hard Science
Magni Martins (1998)

Thank you