Factors Impacting the Flavor of Dried Dairy Ingredients

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Dairy Ingredients: The bottom line

- Competitive, global and expanding market
- What are the keys to success?
  - Make what people want to buy
- Deliver targets to customers
What are the targets?

• In the case of dairy ingredients, functionality and nutrition are targets and so is flavor.

No flavor –

no flavor carry through is the desired target along with no color for whey ingredients

Mild milky flavor –

is the desired target along for milk ingredients
Why IS flavor of protein ingredients important?

- Off-flavors are present in proteins (Carunchia Whetstine et al., 2005; Russell et al., 2006; Drake, 2006; Wright et al., 2006; 2008)
  - All ingredients DO NOT taste the same

- Dried protein ingredient flavor can carry through into finished products (Russell et al., 2006, Drake, 2006; Drake et al., 2008; Childs et al., 2007; Wright et al., 2008)

- >50% consumers today are looking to place more protein into their diet

Delivering Target Flavor

- Know your ingredient(s) – and the competition
  - Understand ingredient flavor and flavor stability
  - Understand the impact of processing parameters!
- Know your applications
- Know your customer(s)
Sensory profiles of WPC80 (Trained panel)

Consumer Acceptability
Liking of peach protein beverages

N=100 consumers

Whey proteins with least Flavor make preferred beverages

Aroma
Overall
### Ideal Attributes for Different Protein Applications

<table>
<thead>
<tr>
<th>N=1012 consumers</th>
<th>Powders</th>
<th>Beverages</th>
<th>Bars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flavor</td>
<td>Chocolate</td>
<td>Chocolate</td>
<td>Chocolate</td>
</tr>
<tr>
<td>Protein Type</td>
<td>Whey</td>
<td>Whey</td>
<td>Whey or Milk</td>
</tr>
<tr>
<td>Protein Amount</td>
<td>20-29g/serving</td>
<td>20-29g/serving</td>
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<tr>
<td>Label Claims</td>
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<td>All-natural</td>
</tr>
<tr>
<td>Carbohydrate Content</td>
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<td>Low Carb</td>
<td>Low Carb</td>
</tr>
<tr>
<td>Sweetener Claims</td>
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</tr>
<tr>
<td>Sweetener Type</td>
<td>Stevia</td>
<td>Stevia</td>
<td>Stevia</td>
</tr>
</tbody>
</table>

**Consistent across platforms!**

### Liking of Protein Beverages

<table>
<thead>
<tr>
<th>N=150 consumers</th>
</tr>
</thead>
<tbody>
<tr>
<td>10g/serving</td>
</tr>
<tr>
<td>10 g vs 20 g/serving</td>
</tr>
</tbody>
</table>

**Flavor of the protein source and amount of protein impact consumer acceptance**
**Protein sensory effects**

- More whey protein: more desirable to consumers *conceptually*
- More whey protein: higher cardboard flavor
- More whey protein: higher viscosity
- More whey protein: higher astringency

- **More protein: more protein-related challenges**

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**Sensory analysis is a requirement**

- **Instruments do not document flavor (or texture)** -- they document chemical or physical properties that we can link to flavor (or texture)
- Sensory analysis with instrumental analysis allows us:
  - Enhanced product understanding
  - Enhanced consumer/customer understanding
  - Sources of flavors
Flavor sources in dairy ingredients

Feed influences flavor of all dairy products

- Aromatic compounds from feeds influence flavor of milk
  - Total mixed ration (TMR) – sweet and malty flavors
  - Pasture-fed, organic – grassy flavors
- Type and intensity of these flavors will vary and depend on feed type, time consumed before milking and season

Key take away: what you feed the cows impacts milk flavor --- and whey flavor
Influence of cheesemake

- Dried whey ingredient flavor starts with the cheese milk
- Different cheesemakes produce different flavored cheese – and different flavored wheys

- Fluid whey already has lipid oxidation compounds
  - Annatto plays no direct role
  - Starter culture increases oxidation
    - mesophilic > thermophilic
    - Differences among mesophilic starters

Key takeaways:

- The cheesemake influences whey flavor
  - Milk whey protein (serum protein) will be distinct in flavor from cheese whey protein
  - Different cheeses are distinct in flavor – so are different wheys
- Lipid oxidation has already initiated in fresh fluid whey
Influence of Processing

- Influence of processing - several sources:
  - Fat separation
  - Membrane sanitation
  - Storage of fluid product
  - Bleaching
  - Homogenization pressure (WMP)
  - Evaporation vs RO (milk and whey powders)
  - Solids and pH at spray dry
  - Spray drying parameters (drier inlet and outlet temp, run time)
  - Storage of dried product and instantization
- Many of these also impact flavor of all dried dairy ingredients!

Influence of Spray Drying

- Spray drying parameters influence flavor of dried dairy ingredients
- Spray drying process increases flavor intensity
  - No impact on solubility across pH or heat stability (p<0.05)
- Higher solids produces lower flavor intensities, decreased aldehydes and greater shelf stability (whey and milk proteins, due to particle size and surface free fat)
Solids and Inlet Temperature

- Higher solids at spray dry:
  - Increased particle size
  - Decreased surface free fat
  - Decreased oxidation and improved flavor
- Similar effect with inlet temperature: higher is better

**Key takeaway:**
spray dry at highest possible solids

Drier Run Time

- Product flavor is not the same across the drier run
  - **Initial:** can have carryover effects from previous product
  - **End:** increased oxidation with increased cardboard flavor and burnt flavor due to burn-on
- Big challenge for QC
  - How are retains or representative samples collected?

**Key takeaway:**
If you are switching products, check and re-check by sensory that you have enough discard bags at beginning of run.
Storage of Powder

- **Instantization**
  - Increases functionality, decreases shelf life

- **Package**
  - 2 and 3-ply bags and totes are common and work
  - Foil or foil liner will prolong shelf life but may not be cost effective

- **Time and temperature**
  - Optimum shelf life of dried dairy proteins is 18-24 mo (tops!)
  - >25°C storage changes the chemistry: Maillard and lipid oxidation
  - Different off flavors, color changes and solubility

Shelf life and Instantization

- Whey protein collected from 4 suppliers in duplicate
  - 3 sources of WPC80
  - 2 sources of WPI
  - Re-wet and single pass
  - With and without added lecithin

- Physical, sensory and instrumental volatiles evaluated across 18 mo storage

**Key takeaway:** Storage time is not infinite - lipid oxidation still occurs
Sampling of dried ingredients

• Ideally – dried ingredient from a single 18-22 h run is the same from beginning to end

• Reality – beginning of run can have carryover from previous, end of run can have flavors due to run time

• Most conservative: 1 or more composite samples and or composite from end of run

Summary: Source of flavors

• Every step from milk receipt to spray dried product to storage and final application influences flavor of dried dairy ingredients

• Optimization of processing parameters can be applied to maximize flavor quality

*Invited review: The effects of processing parameters on the flavor of whey protein ingredients*

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Where is Sensory Used?

Research & Development  Quality Assurance  Marketing
Human Senses

- 7 modalities – vision, olfaction, gustation, chemesthesis, audition, kinesthesis, somesthesis
- All play a role in sensory perception
- Physiology of each modality determines specific sensory testing requirements

Flavor

Sensations perceived via the chemical senses from a product in the mouth.

Aromatics + Basic Tastes + Trigeminal = Flavor
Aroma/Flavor Physiology

Trigeminal nerves (5th cranial nerves)

Gustation (Basic Tastes)

- Along with olfaction, the most widely studied chemical sense
- Perceived by taste buds
- Taste buds are balls of modified epithelial cells with a pore or channel.
  - Solutions make contact with cells through the pore
  - Lifespan of 1 week
- Taste buds are located within the papilla on tongue and soft palate
- Different tastes are not perceived on different areas of the tongue
The Sense of Taste

- Taste: the ability to respond to dissolved molecules and ions
- Physiology
  - Humans detect taste with taste receptor cells. These are clustered in taste buds
  - A single taste bud contains 50-100 taste cells representing all 5 taste sensations

Olfaction: where the flavor is!

- Stimulation of the olfactory epithelium by a volatile compound
- Comprises the majority of what we consider flavor
- Receptors are true nerve cells rather than modified epithelial cells
- More rapid response than basic tastes - 1-2 seconds
- More rapid adaptation – reduced sensitivity under constant stimulation
Chemesthesis

- Stimulation of the trigeminal (cranial) nerves in the mucous membranes of the nose, eyes, mouth, and throat
- Plays a critical role in acceptability of certain foods and pharmaceutical products
- Not a part of flavor for most, if not all, dried dairy ingredients!

Flavor of dried ingredients: How do we measure?

- Sensory analysis – aroma and flavor of REHYDRATED dried whey protein can tell you a lot of information
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- Sensory analysis – aroma and flavor of REHYDRATED dried whey protein can tell you a lot of information
- Rehydrate product at 10% (w/v) solids (*SNF for WMP)
- Evaluate in LIDDED cup at 15-21C
- Evaluate at > 10C – **COLD and NO LID IS NOT GOOD FOR FLAVOR QC**

Flavor of whey protein

- Fresh ideal whey protein will have a mild, sweet aroma with a bland flavor
  - A mild cardboard flavor is ubiquitous
  - Non MF isolates may have low bitter and salty tastes and soapy flavor
  - Instantized products may have faint cucumber flavors
  - International proteins will have a grassy/hay aroma and flavor
- **Target flavor and flavor variance will vary with supplier**
- **Target flavor and flavor variance may vary with ingredient application**

There is tremendous inherent flavor variability among suppliers!
Flavor of milk protein and milk powders

- Fresh ideal milk protein will have a mild, sweet aroma with a bland flavor
  - A faint corn chip flavor is ubiquitous in MPI
  - International proteins will have a grassy/hay aroma and flavor
- Fresh ideal NFDM and WMP will taste like their fluid milk counterparts
  - Higher heat products will have sulfur/burnt notes
  - Mild caramelized flavor is ubiquitous in WMP
  - International proteins will have a grassy/hay aroma and flavor
- Target flavor and flavor variance will vary with supplier
- Target flavor and flavor variance may vary with ingredient application

Sensory Rules

- Be on Time
- No Smoking, Eating, Drinking • 15-30 minutes before panel
- Avoid Distractions
- Don’t wear cologne, perfume, etc.
- Wash your hands before tasting
- Pay attention & participate
Acknowledgements

• National Dairy Council