Encapsulated Flavours
New Horizons for the Delivery of Aroma and Taste
Flander's Food Technology Day, Brussels, September 29-30, 2010
Flavours
Complex Blends of Compounds Providing Aroma and Taste

Shepherd (2006)
Flavours
Complex Blends of Compounds Providing Aroma and Taste

Chandrashekar (2006)
Flavours
Complex Blends of Compounds Providing Aroma and Taste

- Flavour ingredients differ in their physical and chemical properties:
  - Solubility
  - Volatility
  - Partitioning coefficient
  - Reactivity

<table>
<thead>
<tr>
<th>Compound</th>
<th>Apple</th>
<th>Banana</th>
<th>Pear</th>
<th>Pineapple</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alcohols</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-Butanol</td>
<td>30</td>
<td>5</td>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>2-Methyl butanol</td>
<td>30</td>
<td>5</td>
<td>50</td>
<td>5</td>
</tr>
<tr>
<td>1-Hexanol</td>
<td>30</td>
<td>5</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td><strong>Esters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amyl acetate</td>
<td>50</td>
<td>10</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>Isoamyl acetate</td>
<td>5</td>
<td>150</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Ethyl butyrate</td>
<td>5</td>
<td>40</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Amyl butyrate</td>
<td>5</td>
<td>30</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Heptyl acetate</td>
<td>5</td>
<td>5</td>
<td>100</td>
<td>5</td>
</tr>
<tr>
<td>Ethyl-2-methyl butyrate</td>
<td>5</td>
<td>10</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>Allyl caproate</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>120</td>
</tr>
<tr>
<td>Citronellyl acetate</td>
<td>5</td>
<td>5</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td><strong>Aldehydes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hexanal</td>
<td>100</td>
<td>1</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>(E)-2-Hexenal</td>
<td>100</td>
<td>10</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>Benzaldehyde</td>
<td>0.1</td>
<td>0.2</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vanillin</td>
<td>1</td>
<td>30</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>Eugenol</td>
<td>0.1</td>
<td>2</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Ethanol</td>
<td>693.8</td>
<td>686.8</td>
<td>638.6</td>
<td>770.8</td>
</tr>
</tbody>
</table>

Grab (1998)
Flavour Delivery Systems
The “missing link” between flavours and food

- A Flavour Delivery System provides the “missing link” between an (often) hydrophobic flavouring and the (usually) aqueous food base. It can support dissolution or dispersion of flavourings in foods and beverages.

- In flavour encapsulation, the delivery system provides a physical barrier between the flavour and the environment to fulfill a number of additional functions:
  - Protect flavouring from oxidation, moisture uptake, evaporation even under harsh environmental conditions (food processing, freeze-thaw cycles…)
  - Controlled or triggered release – impact, time-intensity profile, temperature, pH, shear
  - Separate incompatible flavour constituents to avoid adverse reactions
Flavour Delivery Systems
Life Cycle

Flavour House

Food Processor

Retail

Consumer

Food production

Food product storage

Food preparation

Consumption

CAPTURE

PROTECT

RELEASE

Transport

Transport

Givaudan

6-12 (24) months
## Flavour Delivery Systems
### Overview of encapsulation technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Particle size (µm)</th>
<th>Flavour load (%)</th>
<th>Release</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Typical</td>
</tr>
<tr>
<td><strong>Spray drying</strong></td>
<td>20</td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td><strong>Compacting</strong></td>
<td>1000</td>
<td>3000</td>
<td>5</td>
</tr>
<tr>
<td><strong>Agglomeration</strong></td>
<td>500</td>
<td>3000</td>
<td>5</td>
</tr>
<tr>
<td><strong>Fluidized spray drying</strong></td>
<td>200</td>
<td>400</td>
<td>20</td>
</tr>
<tr>
<td><strong>Continuous fluidized bed granulation</strong></td>
<td>200</td>
<td>2000</td>
<td>20</td>
</tr>
<tr>
<td><strong>Rotor granulation</strong></td>
<td>200</td>
<td>2000</td>
<td>5</td>
</tr>
<tr>
<td><strong>Extrusion</strong></td>
<td>200</td>
<td>2000</td>
<td>6</td>
</tr>
<tr>
<td><strong>Coacervation</strong></td>
<td>20</td>
<td>800</td>
<td>40</td>
</tr>
<tr>
<td><strong>Submerged nozzle</strong></td>
<td>800</td>
<td>5000</td>
<td>70</td>
</tr>
<tr>
<td><strong>Spray chilling</strong></td>
<td>20</td>
<td>200</td>
<td>10</td>
</tr>
<tr>
<td><strong>Molecular inclusion</strong></td>
<td>5</td>
<td>50</td>
<td>5</td>
</tr>
</tbody>
</table>

Adapted from Uhlemann (2002)
Flavour Delivery Systems
Examples

- **Spray-dried powders**

  - Flavor droplets
  - Carrier (usually complex carbohydrates, water-soluble or water-swollen).

- **Core-shell capsules**

  - Shell made from a complex coacervate (often, with gelatin).
  - Shell is chemically or enzymatically cross-linked.

---

M Schultz, Flanders’ Food Technology Day 2010
Flavour Delivery Systems
Examples (cont’d)

- **Matrix capsules**
  - Matrix material (e.g., calcium alginate)
  - Core Material (medium-chain triglyceride, “MCT”)
  - Filler: additional diffusion barrier + structural support

- **Coated granules**
  - Core: flavor + carrier matrix; composition selected for fast or slow dissolution or swelling
  - Coating for delayed dissolution (fat, or various polymers).
Flavour Delivery Systems
Examples (cont’d)

- **Beverage Emulsions**
  - Oil phase (10-20%)
    - flavour/oil
    - weighting agents
    - (colorants)
  - Water phase (80-90%)
    - water
    - emulsifier
    - preservation system
    - colorants

PRE-HOMOGENISATION

HIGH-PRESSURE HOMOGENISATION

Givaudan
Givaudan®

Pure Delivery™

EverFresh™
make it real

- Authentic
  - Natural, straight-from-the-kitchen flavour and aroma

Lifestyle
- From sugar-free to vegetarian, taste and flavour solutions for any diet

Burst™
choose your release

- Controlled release
  - Aroma and flavour...how you want it...when you want it

- Special effects
  - Flavour hot spots, bursts, and sensations that excite the senses

Pearl™
look taste feel

- Visual Cues
  - Attractive and delicious food impressions

- Textures & Mouthfeel
  - Creamy to crunchy, tactile taste experiences for the eye and palate

UltraSeal™
sealed for perfection

- Bright, Bold Flavour
  - Complete protection of oil-based flavours against oxidation

- High Performance
  - Extended shelf life
  - Uniform distribution of flavour in beverage

M Schultz, Flanders' Food Technology Day 2010
**Flavour Delivery Application Examples**

**Overview of topics**

I. Stabilisation of citrus flavours for long shelf life performance in dry powder applications

II. Controlled release systems in chewing gum

III. Flavour protection during thermal processing

IV. Long lasting cooling sensations

---

[Givaudan Logo]
Summary

- Flavours are complex blends of compounds with different physical and chemical characteristics.

- Traditionally, flavour encapsulation technologies provide means to capture, protect and release flavours in a controlled way taking into account the potential changes in flavour composition during processing, storage and application in foods and beverages.

- Nowadays, these tasks are complemented by providing delayed or sequential release effects, protection during baking and frying procedures, and taste related effects like cooling sensation, sweetness enhancement and bitter masking.

- Tailor-made solutions are possible in close cooperation between customers and flavour companies.
Bibliography


