Citri-Fi® Natural Citrus Fiber
“Using Shear to Improve Sauces and Dressings”

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Citri-Fi, a Versatile Formulating Tool

- Citri-Fi is a fiber of the citrus fruit cell wall that delivers a natural texture as a food ingredient
- Clean label: labeled as citrus fiber, dried citrus pulp or citrus flour
- One ingredient with multiple functionalities in food:
  - Minimal syneresis or separation
  - Thickening
  - Emulsification or oil control
  - Mouthfeel and body
  - Freeze-thaw stability

### Composition

<table>
<thead>
<tr>
<th>Composition</th>
<th>Citri-Fi 100 (Citrus Fiber)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soluble Fiber</td>
<td>34.7%</td>
</tr>
<tr>
<td>Insoluble Fiber</td>
<td>41.4%</td>
</tr>
<tr>
<td>Total Fiber</td>
<td>76.1%</td>
</tr>
<tr>
<td>Protein</td>
<td>7.0%</td>
</tr>
</tbody>
</table>
Citri-Fi forms an emulsion which remains stable for weeks

- Citri-Fi holds three times its weight in oil.
- Citri-Fi 100M40 is premixed with oil.
- Water opens up the fiber further to allow more oil to bind.
- The fiber continues to bind oil and water and swell.
- Hydration is complete when the emulsion is formed.
- Emulsions remains stable for weeks after formation.
Photos of Rehydration

- Photos from 0 - 20 seconds
- Fibers rapidly swell and lose fibrous identity in water
- Gel-like appearance forms after hydration
Water Holding Capacity vs. Shear And Temperature

- Shear effects opens the fiber even more to create additional surface area
- Shear can quicken & elevate water holding capacities
- Temperature had no effect

Source: Schalow et al., 2017
Shear Effects of Citri-Fi

• Shear opens up the fiber to create additional surface area and volume which increases viscosity

• Shear Methods:
  • No Shear – stirring, mixing
  • Mild Shear – blender, Likwifier
  • Moderate Shear – colloid mill, Koruma, IKA, etc.
  • High shear – piston homogenizer
Citri-Fi Emulsions: Effect of Homogenization Pressure

Shear effects open the citrus fiber to create additional stabilization for food products exposed to adverse conditions.

- The consistency of emulsions can be improved by high pressure homogenization
- Citri-Fi can be dispersed either in aqueous phase or oil
- Increased pressure
  - reduces oil droplet size
  - enhances water binding of Citri-Fi

**Composition:**
- 2 % Citri-Fi 100FG
- 25 % Oil
- 73 % Water

<table>
<thead>
<tr>
<th>Pre-emulsion by hand</th>
<th>100 bar</th>
<th>200 bar</th>
</tr>
</thead>
</table>

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Thicker, Richer Tomato Sauces

Citri-Fi can be used to thicken sauces when exposed to shear

**Highlights**

- Large boosts in *sauce thickness* can be achieved using <1% Citri-Fi
- Use shear to *fray and comingle* the tomato and citrus fibers intimately
- Can use technique to:
  - reduce cost while maintaining texture and flavor
  - or, drive preference by improving body, color and flavor

**Graph:**

- **X-axis:** Shear (homogenizer psi)
- **Y-axis:** INCREASING Thickness (Bostwick cm)

- **Legend:**
  - Control 12% NTSS
  - 12% NTSS + 0.8% CF125FG

**Graph Data Points:**

- Control 12% NTSS:
  - 0 psi: 4.0 cm
  - 500 psi: 4.5 cm
  - 1000 psi: 5.0 cm
  - 1500 psi: 5.5 cm
  - 2000 psi: 6.0 cm
  - 2500 psi: 6.5 cm

- 12% NTSS + 0.8% CF125FG:
  - 0 psi: 4.0 cm
  - 500 psi: 4.5 cm
  - 1000 psi: 5.0 cm
  - 1500 psi: 5.5 cm
  - 2000 psi: 6.0 cm
  - 2500 psi: 6.5 cm
Improving Texture of Tomato-based Sauces with Citri-Fi

Formulation:

<table>
<thead>
<tr>
<th>Simple Enhanced Tomato Sauce</th>
<th>Control</th>
<th>Citri-Fi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.0% Citri-Fi</td>
<td>0.2% Citri-Fi</td>
</tr>
<tr>
<td></td>
<td>pounds %</td>
<td>pounds %</td>
</tr>
<tr>
<td>Tomato Paste (31% NTSS, HB)</td>
<td>96.78 38.7</td>
<td>96.58 38.6</td>
</tr>
<tr>
<td>Water</td>
<td>153.23 61.3</td>
<td>152.92 61.2</td>
</tr>
<tr>
<td>Citri-Fi</td>
<td>0.00 0.0</td>
<td>0.50 0.2</td>
</tr>
<tr>
<td>Total</td>
<td>250.00 100.0</td>
<td>250.00 100.0</td>
</tr>
</tbody>
</table>

Control (0% Citri-Fi )

0.2% Citri-Fi
Use a Bostwick To Measure How Thick And Rich The Sauce Is

(lower numbers are thicker)

12% NTSS Control
2500 psi homogenization
Bostwick = 6.3

12% NTSS + 0.2% CF
2500 psi homogenization
Bostwick = 4.4
Improving Tomato Sauce Organoleptic Quality

Citri-Fi can be used to improve tomato sauce texture and quality without reducing the tomato solids

Blind Internal Sensory Panel
12% NTSS Tomato Sauce

- Adding Citri-Fi without reducing tomato solids:
  - Improves color
  - Improves flavor
  - Improves thickness
  - Improves preference
Cost Out

- Using high shear, one can keep the thickness of a tomato-thickened sauce but reduce tomato paste content by 15% using 0.2 to 0.4% addition of Citri-Fi 100 series.

- Net reduction in paste cost 6-10% using current volume pricing.

Source: www.tomatonews.com
## BBQ Sauce Formulation & Methods

### Citri-Fi Incorporation:
Citri-Fi is added to the dry ingredients such as sugar, salt and spices.

### Cook:
- **Temp:** 85°C
- **Time:** 10 Minutes

### Bostwick Results:
- Starch: 9.3
- Citri-Fi: 8.0

### Ingredient Table

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Physically Modified Starch (%)</th>
<th>Citri-Fi 100 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td>29.860</td>
<td>29.860</td>
</tr>
<tr>
<td>Tomato Paste</td>
<td>11.200</td>
<td>11.200</td>
</tr>
<tr>
<td>Vinegar</td>
<td>7.875</td>
<td>7.875</td>
</tr>
<tr>
<td>Molasses</td>
<td>6.030</td>
<td>6.030</td>
</tr>
<tr>
<td>Salt</td>
<td>1.400</td>
<td>1.400</td>
</tr>
<tr>
<td><strong>Citri-Fi 100</strong></td>
<td><strong>0.000</strong></td>
<td><strong>1.500</strong></td>
</tr>
<tr>
<td>Starch</td>
<td>3.260</td>
<td>0.000</td>
</tr>
<tr>
<td>Spice Mix</td>
<td>1.180</td>
<td>1.180</td>
</tr>
<tr>
<td>Water</td>
<td>39.195</td>
<td>40.955</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>
BBQ Sauces Textures

BBQ sauce containing sheared Citri-Fi is thick with consistent texture

Control (Starch) BBQ Sauce

Citri-Fi BBQ Sauce

Atomo 3.0 Lab Homogenizer, Bertoli - Italy
• Citri-Fi citrus fiber is functional as-is, but using high shear equipment in a commercial food process can activate a powerful increase in viscosity
• Using shear to unlock viscosity is a useful clean label tool to thicken and stabilize sauces and dressings
• Citrus fiber works nicely to stabilize sauces containing fats and oils
• Citrus fiber is much more temperature-independent than other hydrocolloids
• Citrus fiber is naturally stable to acidic conditions
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