Crystals®
A Taste of Who We Are

Presented to:
The Technical Committee for Juice and Juice Products
March 4, 2010
Agenda

• Overview
  – Kerry Worldwide
  – Kerry Ingredients & Flavours
    • Crystals®

• Technology Overview

• Product Lines

• Applications

• Product Demonstration
Crystals® Overview

- Founded as a Government and NASA supplier
- Proprietary Freeze-drying Technology
- Located in Plant City, Florida USA
- Acquired by Kerry Group, September 2003
Technology Platforms/Functional Benefits

**Extraction**
Processing & “Cleansing” of herbs & spices, vanilla, botanicals for flavor & fragrance applications

**Distillation**
Citrus & fruit flavors, oils & extractions for added freshness, taste & intensity

**Reaction Technology**
Cooked savory & sweet flavors for fresh & “just cooked” flavors for prepared foods

**Pyrolysis**
Smoke flavors, browning systems, anti-microbial properties

**Freeze Drying**
Provides instant solubility, a unique flavor delivery system, intense flavor profiles

**Encapsulation**
Methods of capturing, protecting & delivering flavors: spray drying & other methods acquired in Italy
Continuous Vacuum Belt Dryer
Continuous Vacuum Belt Freeze-Drying

- High vacuum
- Low temperature
- Moderate cost
- High production rate compared to tray/cabinet drying

- High quality
- Superior solubility
- Excellent sensory characteristics
- Best suited for juice and puree

- Typically, freeze-drying is associated with high cost.
- The Continuous Vacuum Belt Dryer is an exception. The ability to dry thin films on a continuous basis keeps costs at a reasonable level.
The History of the Process
• In 1946, freshly squeezed and canned juices were unavailable.
• In 1948, frozen orange juice concentrate was developed.
• In the 1950s, the USDA developed a process to provide instant Orange and Grapefruit juice to the US Military.
• As a result of the USDA studies, the continuous vacuum belt dehydrator was developed to freeze dry orange and grapefruit juices.
The First Dryer

This was delivered in 1955 to Orange Crystals, Inc., the roots of Crystals International (CII), which is now Kerry Ingredients & Flavours.
Original Plant
#1 Dryer Installed & Ready for Operation
Filling Cans in the 1950s
Labeling Cans
The Nature of Vacuum Belt Freeze Drying
CRYSTALS UNIQUE FREEZE-DYING PROCESS
A dryer consists of a large vacuum chamber containing a stainless steel belt moving about 30 feet or 9 meters per minute.

The operating pressure for freeze-drying is 1 to 2 millimeters of pressure absolute. The pressure in this room is 760 mm of Mercury.

There is essentially no oxygen present to cause oxidation, the boiling point of water is reduced, and the heating is very gentle, all combining to give good characteristics to produce a high-quality product with .7 to 2.5% residual moisture.

The primary wear parts are stainless steel belts and bronze doctor blades.

Wet product is handled in all stainless steel equipment or in food grade plastics.
Pilot Dryer
By using the pilot plant, we are able to improve uniformity and learn about controlling:

- Degradation
- Moisture
- Hygroscopicity
- Particle Size
- Bulk Density
- Flowability
Standard Product List

**Crystals®**

Freeze-dried Fruit & Vegetable Juice Powders

Apple  Mango
Banana  Mixed Berries
Beet  Orange
Blackberry  Papaya
Black Currant  Passion Fruit
Blueberry  Peach
Carrot  Pear
Cherry, Dark Sweet  Pineapple
Cherry, Red Sour  Pomegranate
Cranberry  Pumpkin
Grape  Raspberry
Grapefruit  Strawberry
Key Lime  Tangerine
Kiwi  Tropical Blend
Lemon  Watermelon

**Crystal Caps™**

Freeze-dried Fruit Juice Powders in Kiwi & Mango

**Crystals® Organic**

Freeze-dried Fruit and Vegetable Juice Powders in Apple, Banana, Beet, Carrot, Grape, Lemon, Mango, Peach, Pineapple, Pomegranate & Raspberry Cranberry

**Crystals® Specialty**

Freeze-dried Powders in CrystaLac®, Balsamic Reduction, Molasses, Honey, Organic Honey, Organic Molasses, Passion Fruit WONF & Raspberry WONF
Made-to-Order Product List

**Freeze-dried Powders**

**Crystals®**
- Freeze-dried Fruit and Vegetable Juice Powders
- Acerola
- Acerola Acai Blend
- Apricot
- Blood Orange
- Celery
- Guava
- Mangosteen
- Plum
- Purple Carrot
- Raisin
- Spinach Extract

**Crystals® Organic**
Freeze-dried Fruit Juice Powders in Cranberry, Honey, Orange, Passion Fruit, Yumberry, & Maple Syrup

**Crystals® Organic Flavors**
Freeze-dried Fruit Juice Powder Flavors in Apple, Banana, Dark Sweet Cherry, Cranberry, Grape, Lemon, Orange, Peach, Pineapple, & Strawberry

**Crystalettes®**
Freeze-dried Fruit Juice Powder in Tangerine

**Crystals® Specialty**
Freeze-dried Powders in Burgundy Wine/Grape, Honey, Lemon w/ art. color, Lime w/ art. color, Maple Syrup, Spinach Extract & Sweet Marsala

**SuperNatural Flavors™**
Freeze-dried Powder Flavors in Blueberry, Dark Sweet Cherry, Lemon, Orange, & Raspberry

**NutraFlavors™**
Freeze-dried Powder Flavors in Apple, Blackberry, Cranberry, Grape, Natural Green Tea, & Pomegranate

Q3-2009
Prototype Products

- Custom Juice Blends
- Chamomile Extract
- Echinacea
- Elderberry
- Green Bell Pepper
- Organic Black Malt
- Red Radish
- Sherry Wine
- White Cranberry
Crystals® Key Product Properties

Superior Quality

- **Flavor**
  - Excellent flavor retention provides ‘true-to-nature’ flavor profile
  - Provides natural sweetness and acidity
  - Crystals® have much fresher flavor character and no cooked notes compared to spray-dried juices

- **Nutritional value**
  - Freeze drying process does not destroy functional nutrients like Vitamins, Proteins, etc.
  - Crystals® nutrient value is much higher compared to spray-dried juices

- **Color**
  - Freeze drying process retains natural color characteristics of starting juice
    - no degradation of color
    - no browning of color
  - Crystals® color properties are superior compared to spray-dried juices
Crystals® Key Product Properties

Operational Advantage

• Excellent solubility in cold and hot water
  – Crystals® can replace the use of liquid juice concentrates

• Compatible with low/intermediate moisture foods
  – Crystals® are extremely suitable for low/intermediate foods
  – Liquid juice concentrates cannot be used in this application

• Easy handling
  – Crystals® do not need de-frosting time, they are ready to use
  – Liquid juice concentrates need de-frosting time, which creates possible micro issues
  – Crystals® are more efficient in use, no loss of product. Liquid juice concentrates are usually associated with product losses due to spoilage of partial drums, etc.

• Easy storage
  – Crystals® do not require freezer storage, temperature controlled 70°F/20 °C or less
  – Crystals® are less bulky, all the water is removed. Saves on shipping costs and requires less storage capacity
  – Liquid juice concentrates need refrigerated or frozen storage

• Microbial Stability
  – Crystals® are extremely micro stable
  – Liquid juice concentrates spoil quickly at ambient temperatures

• Long shelf-life stability
  – Crystals® have long shelf-life stability (12-24 months minimum)
  – Liquid juice concentrates expire within 6-12 months
Crystals® Key Product Properties

Label Claims

• 100% Natural
• Real juice / Real fruit (regulatory requirement in certain applications)
• Provides juice solids (regulatory requirement in certain applications)
• Clean ingredient declaration
• Organic, non-GMO versions available
• Lemon and Lime Crystals® act as Natural acidulant
• Honey, Molasses, and Maple Syrup Crystals® provide natural sweetener alternative
Freeze Dried Powders

Comparison...

...of fresh fruit juice equivalent to one kilogram of freeze dried powders

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Equivalent to 1 kg of Crystals® Freeze-dried Fruit Powders</th>
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<tbody>
<tr>
<td>99 oranges</td>
<td>1 kg of Crystals® Orange Freeze-dried Fruit Powders</td>
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<tr>
<td>156 lemons</td>
<td>1 kg of Crystals® Lemon Freeze-dried Fruit Powders</td>
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<tr>
<td>192 limes</td>
<td>1 kg of Crystals® Lime Freeze-dried Fruit Powders</td>
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<tr>
<td>158 carrots</td>
<td>1 kg of Crystals® Carrot Freeze-dried Fruit Powders</td>
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<td>Liquid Juice Concentrates</td>
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<td><strong>Flavor</strong></td>
<td>Standard Flavor</td>
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<td><strong>Color</strong></td>
<td>Standard Color</td>
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<td><strong>Nutritional value</strong></td>
<td>Standard Nutritional</td>
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<td><strong>Solubility</strong></td>
<td>Standard Solubility</td>
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<tr>
<td><strong>Handling Storage</strong></td>
<td>Thawing needed</td>
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<td>Frozen storage</td>
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<tr>
<td><strong>Microbial Stability</strong></td>
<td>Prone to microbial spoilage if not stored properly</td>
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<tr>
<td><strong>Shelf-life Stability</strong></td>
<td>6 – 12 Months</td>
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Product Applications

• Beverage
• Sweet
• Savory
• Nutraceutical
Product Applications - Usage

• Beverage
  – 100% Juice:
    • 8 – 25% w/v Crystals®
  – Brewed Tea:
    • 0.2 - 1.0% w/v Crystals®
  – Smoothies:
    • 2 - 10% w/v Crystals®
  – Carbonated Soft Drinks (3-10% Juice):
    • 0.15 – 2.5% w/v Crystals®
Product Applications - Usage

- **Sweet**
  - Fillings:
    - Crystals® 5-8% w/w
  - Candy:
    - 0.5 - 1.0% Crystalettes® w/w
    - 2.5 – 4 % Crystals® w/w
  - Soft Serve Ice Cream:
    - Crystals® Fruit Powders: 0.5 – 1.5 % wt/vol
    - CrystaLac® Dairy Powders: 1.5 – 2.5 % wt/vol
  - Baked Goods:
    - Crystals® 2 – 14% dry weight
    - Crystalettes® 0.5 - 1.2% dry weight
Product Applications - Usage

- Savory
  - Seasoning Blends:
    - Crystals® 5 - 30% w/w
  - Sauces and Dressings:
    - Crystals® 10 - 20% w/w
  - Retorted Soups:
    - Crystals® 5 - 10% w/w
  - Dairy Spreads:
    - Crystals® 5 - 20% w/w
Nutraceutical - Usage

• Nutraceutical
• As needed for functional effect in previously mentioned applications
  – Capsules:
    • Crystals® 5 - 20% w/w
  – Tablets:
    • Crystals® 5 - 20% w/w
Thank You!