Sweetener Technology
Historic Sweeteners
Honey

• Relative Sweetness*
  – 1.33

• History
  – Original sweetener
  – 8000 years ago
  – Multiple religious ceremonial uses

• About
  – Classified by floral source
  – Graded by color and optical density USDA

• Typical Analysis
  – Fructose 38%
  – Glucose 31%
  – Sucrose 1%
  – Water 17.2%
  – Ash 0.2%

*Sucrose has a relative sweetness of 1.00
Honey continued

• Forms
  – Raw
  – Pasteurized
  – Strained
  – Filtered
  – Whipped
  – Crystallized
  – Dried

• Sources
  – US, Chile, India, Viet Nam, China, Turkey, Argentina

• Formulation Considerations
  – GMO vs Non-GMO
  – Botulism
    • Adults
    • Children under 1 (some say 2)
Sugar Beets

- Relative Sweetness*
  - 1.00

- Beta vulgaris L.

- Beet facts
  - 15-20% sugar
  - Temperate growth zones
  - Use dates back to 16th Century
  - Top producers
    - France, US, Germany, Russia
    - 50% of world production

*Sucrose has a relative sweetness of 1.00
Sugar Beet Refining

Flow chart - white sugar manufacture from beet

Key to symbols:
- Process flow
- Gaseous, solid and liquid emissions
Sugar Beets continued

• Products
  – Molasses
    • Animal feed
    • Further processed—citric acid, yeast
  – Betaine
    • Animal feed
    • Chemical raw material—hair products
  – Ethanol
    • By-products
  – Granulated sugar and further processed items
    • Human consumption

• One significant issue with beet sugar is the odor of the dry product (earthy)
Sugar Cane

- Relative Sweetness
  - 1.00

- Saccharum L.
  - 6-37 species of tall perennial grasses
  - 6-19 ft tall

- Facts
  - 80% of world’s sugar
  - Regions – top 4 world producing
    - Brazil
    - India
    - China
    - Thailand
  - Dates back to between 4th and 6th Century BC
  - Commercial production 18-19th Centuries

*Sucrose has a relative sweetness of 1.00*
From cane sugar to granulated sugar
• Common Products
  – Liquids
    • Molasses
    • Golden Cane
  – Dry
    • Turbinado
    • Demerara
    • EFG
    • Powdered
    • Brown
  – By-Products
    • Ethanol
    • Bagasse
Sweetener Technology
Corn Based
Corn Syrup

- Relative sweetness*
  - Low DE—0.40
  - High DE—0.60
- Liquid product
- Also referred to as “Glucose Syrup”
- Production
  - Acid hydrolysis
  - Enzymatic treatment w/alpha-amylase
- Functionality
  - Thickening
  - Humectant
  - Sweetener
  - Browning
- Applications
  - Candies
  - Soft drinks
  - Candies

*Sucrose has a relative sweetness of 1.00
HFCS

- Relative sweetness*
  - 42DE = 0.70-0.80
  - 55DE = 1.00
  - 90DE = 1.60

- Liquid only

- Production
  - Overall
    - Mill corn
    - Corn starch + alpha-amylase
    - Corn syrup + glucoamylase
    - Simple glucose + xylose isomerase
    - Resultant is HFCS 42
  - 42DE
    - Result of first pass w/enzymes
    - 42% fructose + 50-52% glucose
  - 55DE
    - Blend of 42 + 90
    - 55% fructose + 42% glucose
  - 90DE
    - Further refined 42 using liquid chromatography
    - 90% fructose + 10% glucose

*Sucrose has a relative sweetness of 1.00
• Applications
  – HFCS 42
    • Beverages
    • Baked goods
    • Cereals
  – HFCS 55
    • Almost exclusively in soft drinks
  – HFCS 90
    • Specialty applications
    • Manufacturing of HFCS 55
Corn Syrup Solids

• Relative sweetness*
  – 20DE—0.23
  – 42DE—0.48

• Glucose Solids

• Enzymatic treatment of corn starch

• DE range 24 to 42

• Functionality
  – Browning
  – Sweetness
  – Binding
  – Solubility

*Sucrose has a relative sweetness of 1.00
Sweetener Technology

Polyols
Xylitol

• Relative Sweetness*
  – 1.00

• Source
  – Hydrogenated xylose
  – Corn and hardwoods, especially beechwood

• Applications
  – Must be labeled with statement regarding gastric distress
  – Chewing gums
  – Oral hygiene products

*Sucrose has a relative sweetness of 1.00
Erythritol

- Relative Sweetness*
  - 0.70

- Source
  - Enzymatic fermentation of corn sugars
  - US is GMO
  - China is non-GMO

- Application
  - No gastric issues
  - Frostings, chocolate bars, chewing gum
  - Cooling effect

*Sucrose has a relative sweetness of 1.00
Sorbitol

• Relative Sweetness*
  – 0.60

• Source
  – Natural—stone fruits
  – Chemical—acid reduction of glucose

• Application
  – Diet drinks, ice cream, mints
  – Laxative effect

*Sucrose has a relative sweetness of 1.00
Mannitol

• Relative Sweetness*
  – 0.50

• Sources
  – Synthesis—hydrogenation of fructose
  – Biological synthesis—microbial fermentation
  – Natural extraction—soxhlet extraction

• Applications
  – Hard candies, dried fruits, chewing gums
  – Laxative effect

*Sucrose has a relative sweetness of 1.00
Maltitol

- Relative Sweetness*
  - 0.90
- Dissaccharide produced by hydrogenation of maltose
- Applications
  - Hard candies, syrups, chewing gums, etc
  - Browns and liquifies similar to sucrose
  - Liquifies in warm water
  - Laxative effect

*Sucrose has a relative sweetness of 1.00
Isomalt

- Relative Sweetness*
  - 0.45-0.65

- Approvals
  - 1990 FDA
  - Permitted in EU

- Application
  - Crystallize like sugar. Mostly in cake decorating.
  - Issues
    - Gastric issues
    - 50g/day adults
    - 25g/day children

*Sucrose has a relative sweetness of 1.00
Louis Dreyfus Commodities

Sweetener Technology

Artificial Sweeteners
Saccharin

- Relative Sweetness*
  - 300
- Several methods of production
- Name derived from Saccharine
- Typically used in Na form due to stability and solubility
- Origins in 1878
- Growth in World War 2 and Post WWII

*Sucrose has a relative sweetness of 1.00
Cyclamates

- Relative Sweetness*
  - 30
- Sulfonation of cyclohexamine
- Dates back to 1937
- 1966 intestinal and bladder issues
- 1969 ban implemented
- Approved in 55 countries

*Sucrose has a relative sweetness of 1.00
Aspartame

- Relative Sweetness*
  - 180

- History
  - G.D. Searle
    - First synthesized 1965
    - Patent expired in 1992
  - 1985 Monsanto purchased Searle and created Nutrasweet company

- Approvals
  - 1980 US FDA
  - 1994 EU-wide
  - Ajinomoto currently owns 40% of the world-wide market

- Two proprietary production processes

- Stability
  - Not heat stable
  - Not acid stable alone

- Health concern is the high level of phenylalanine which requires labeling in the US and UK. Canada require level of aspartame.

*Sucrose has a relative sweetness of 1.00
Sucralose

• Relative Sweetness*
  – 600

• History
  – 1976 discovery Tate & Lyle
  – Approvals
    • 1991 Canada
    • 1998 US FDA
    • 2004 EU
  – 2008 first generic version

• Production
  – Singapore & Mobile, AL
  – Selective chlorination of sucrose

• Stability
  – Acid
  – Heat

*Sucrose has a relative sweetness of 1.00
Acesulfame-K

- Relative Sweetness*
  - 200
- History
  - 1967 Hoechst AG
  - Now marketed by Nutrinova a division of Celanese
- Application
  - Blends
    - Aspartame
    - Sucralose
  - Heat stable
  - Acid stable
- Flavor Issue
  - Metallic note from potassium

*Sucrose has a relative sweetness of 1.00
Neotame

• Relative Sweetness*
  – 6,000
• Most similar chemically to aspartame
• Metabolically does not cause phenylalanine issues
• Approvals
  – FDA GRAS in 2002
  – EU approved
• Usage
  – Broad spectrum potential
  – Very little application due to dosage

*Sucrose has a relative sweetness of 1.00
Sweetener Technology

Natural Sugar Substitutes
Stevia

- Genus of 240 species of herbs/shrubs
  - Sunflower family
  - *Stevia rebaudiana*—most common
- Growing Regions
  - Western North America, South America, China
- Approvals
  - US—December 2008
  - EU—December 2011
  - Canada—2012
- Flavor Responses
  - Relative Sweetness*
    - Reb-A ~300
    - SG-95 multiglycoside ~200
    - Other glycosides ~100-200
  - Bitter or sour notes
    - Aglycones
- Extraction
  - Parts: Leaves, stems, stalks, whole plant
  - Method: Grind/macerated, Water, Alcohols

*Sucrose has a relative sweetness of 1.00
Luo Han Guo (Monk Fruit)

- **Siraitia grosvenorii**
- **Growing Regions**
  - Northern Thailand (no significant commercial production)
- **Approvals**
  - US—2010 and 2011
  - Canada—not approved
  - EU—not approved
- **Flavor Responses**
  - Relative Sweetness*
    - Mogroside V—~300
    - Momodica 80%—~180-200
  - No off notes
  - Momordica does have a slight “rind” note.

*Sucrose has a relative sweetness of 1.00
• Extraction
  – Parts
    • Fruit
    • Green with darker green stripes
    • 5-7 cm in diameter
  – Method
    • Proctor & Gamble Patent — Sunny Delight 1991
    • Grind/macerated
    • Water
    • Some processes finish with solvents to strip undesirable aromatic compounds

• Perceived Health Benefits
  – Antioxidant
  – Throat inflammation
  – Constipation
  – Diabetes
Thaumatin

- Not commercially available
- Due to high sweetener intensity, Thaumatin is used at very low levels in food (2-5 ppm when in pure form) [50-200 ppm of 18% Thaumatin]
- Very low levels do not make it necessary to change product formulation
- Thaumatin has no known adverse effects and no daily maximum intake limit (ADI)
- Water soluble with resistance to acidity makes it well suited for soft drinks
- Stable in most food and beverage formulations, has long shelf life
- Has bitterness masking characteristics - hence complimentary with many other sweeteners
- Thaumatin is recognized as safe according different guidelines in the EU (94/35/EC; 95/2/EC, 2003/115/EG, 88/388/EC), Switzerland, USA, Canada, Israel, Mexico, Japan, Korea, Singapore, Hong Kong, Australia, New Zealand and South Africa
Imperial Sugar
Sweeteners Options

– Imperial Sugar Brand
– Savannah Gold® Family
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<th>Imperial Sugar Brand</th>
<th>Louis Dreyfus Commodities</th>
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<tr>
<td>• Granulated Sugar</td>
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<td>• Liquid Sugar</td>
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<td>• Invert Sugar</td>
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<td>• Brown Sugar</td>
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<td>• Powdered Sugar</td>
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<tr>
<td>• US and Mexican Sourcing</td>
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</tbody>
</table>
• Choice of 100% Natural Ingredients
  – Pure Cane Sugar
  – Molasses
  – Honey
  – Maple Syrup
  – Customizable—e.g. cinnamon, agave, flavor blends, etc.

• Portion Control
  – Ease of use and packaging
  – Easily blended with dry ingredients—e.g. oatmeal, bake mixes, drink mixes, etc.
    • Free Flowing
    • Compound Crystallized

• Easy to handle…Easy to blend…Easy to dose…Water Soluble

• All products are--
  – 100% Natural
  – OU Kosher Certified
  – Non-GMO
  – GRAS
Reduced Sugar Sweetener Options
– Symple™ Family
Key Benefits

- Reduces sugar usage without reducing sweetness
  - Use 50% to 67% less depending on desired product characteristics
- Easy to handle
- Easy to blend
- Easy to dose
- 100% soluble in water
Reduced Sugar Sweeteners – Symple™

• Symple™ Cane
• Pure Cane Sugar + Monk Fruit Extract (Luo Han Guo)
  – White in color
  – Flavor profile of granulated sugar
  – Compound Crystallized—homogeneous distribution
  – Free flowing—easy to apply and meter
  – Usage
    • Application dependent
    • Up to a 67% sugar reduction
  – Options
    • Coarse granule

Innovation = Reduced Sugar Claim = Cost Competitive to Heritage Savannah Gold® applications
Reduced Sugar Sweeteners – Symple™

Sucrose versus Monk Fruit Sweetener

- Sweet
- Papery (Dusty)
- Metallic
- Salt
- Sour
- Bitter
- Caramelized

Sucrose
Monk Fruit
Reduced Sugar Sweeteners – Symple™

• Symple™ Flavored

• Products
  – Brown
    • Typical flavor profile of light brown sugar and Turbinado sugar
  – Molasses
    • Typical molasses flavor profile found in dark brown sugar
    • 50% reduction in Brown Sugar = same distinct flavor of 100% Brown Sugar
  – Honey
    • Typical honey flavor profile

• Reduced Sugar contribution to Glycemic Index

Innovation = Reduced Sugar Claim = Cost Competitive to Heritage Savannah Gold® applications
Zero Calorie Sweetener Options
– Symple Slym™
Symple Slym™: Zero Sugar Sweetener

- Fused granulation of Erythritol + Natural High Intensity Sweetener(s)
  - No sweetness separation
  - Eliminates “hot” and “cold” sweetener spots and non-uniform product results
  - Uniform Particle Size Distribution (PSD)

- Label as—
  - 100% Natural
  - Non-GMO
  - Sugar free
  - ZERO calories per serving
  - No Flavors Added
  - Product of China

- FDA GRAS for all Ingredients
- Dedicated supply chain
- Low cost provider
- Reduced dust versus competition
Other Sweetener Systems
– Symple Slym™
Other Sweetener Systems

• Molasses
  – Golden Cane Syrup
  – Cane Syrup with Honey

• Turbinado

• Less Refined Sugars — compound crystallized
<table>
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<th>Specialty Syrups</th>
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<tr>
<td>Molasses</td>
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<tr>
<td>• Refiners Molasses</td>
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<tr>
<td>• 79.5 Brix</td>
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<tr>
<td>• Heavy and Strong Taste</td>
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<tr>
<td>Molasses Blend</td>
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<tr>
<td>• Tailored Taste</td>
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<tr>
<td>• Brix to Product Specification</td>
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<tr>
<td>• Kickout Syrup</td>
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<td>• (Brown Sugar Syrup)</td>
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<tr>
<td>• Char Liquor</td>
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<tr>
<td>• Leafcoat</td>
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<td>• Golden Cane Syrup</td>
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<td>• Blend to Customer Requirements</td>
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<td>Base Syrup + flavor components = custom blend</td>
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<td>• Agave</td>
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<td>• Honey</td>
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<td>• Strawberry</td>
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<td>• Orange</td>
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<td>• Grape</td>
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“The ISC Solution”

“Develop Brand recognition while maintaining consumer individual identity”