



CLEAN LABEL CONFERENCE

Fruit and Vegetable Ingredient Toolbox

Opportunities for Clean Label Formulation

MERLIN
DEVELOPMENT

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Agenda

- ▶ Clean Label Definition
- ▶ Functions Needed
 - ▶ Sweetener
 - ▶ Color
 - ▶ Texturizer
 - ▶ Preservative/Antimicrobial
 - ▶ Fortification
 - ▶ Flavor

Qualifiers

- ▶ Examples used are taken from the marketplace and public information.
- ▶ Products cited are not Merlin projects to ensure our client's confidentiality

Definition of “Clean Label”

- ▶ Currently no regulatory definition of Clean Labeling
- ▶ Generally accepted as:
 - ▶ Removal of chemical sounding ingredients
 - ▶ Ingredient names not easily recognized by consumers
 - ▶ Simpler Ingredient List
 - ▶ More “Natural” sounding additives
 - ▶ No regulatory definition of Natural
 - ▶ Whole Foods List
 - ▶ Healthier Nutrient Profile
 - ▶ Non-GMO and Organic claims

Clean Label Formulating

▶ Ingredients that are often targeted for removal

- ▶ Sweeteners
- ▶ Colorants
- ▶ Texturizers
- ▶ Antimicrobials/Preservatives
- ▶ Vitamins/Minerals
- ▶ Emulsifiers
- ▶ Artificial flavors

Potassium
Sorbate

Polysorbate 80

FD&C Red 40

High Fructose
Corn Syrup

Hydroxypropyl
methyl cellulose

Clean Label Formulating

- ▶ Quality or Process that may be affected
 - ▶ Shelf Life
 - ▶ Distribution temperature
 - ▶ Product Variability
 - ▶ Process Parameters
 - ▶ Temperature
 - ▶ Process tolerance
 - ▶ Product Appearance
 - ▶ Cost

Sweeteners



Properties of Sweeteners

▶ Colligative Properties

- ▶ Freezing point depression
- ▶ Boiling Point Elevation
- ▶ Osmotic Pressure
- ▶ Vapor Pressure (Water Activity)

▶ Functional Properties

- ▶ Flavor/Sweetness
- ▶ Water Control
- ▶ Viscosity
- ▶ Foam Stabilization
- ▶ Cohesiveness
- ▶ Crystallization control
- ▶ Texture modification via glass transition

Fruit & Vegetable Derived Sweeteners

- ▶ Fruit sources are a well known way to provide sweetness. Juice concentrates and purees are common forms used.
 - ▶ Examples: Pear, apple, white grape/raisin, plum/prune
- ▶ There are also vegetable sources.
 - ▶ Sugar beets-common source of sucrose (100% GMO)
 - ▶ Note: Sucrose (Evaporated Cane Juice) is currently used in many clean label products.
 - ▶ Sweet potato juice
 - ▶ Carrot juice

Liquid Sweetener Composition

Source	% Total Sugars/Solids	% Fructose	% Glucose	% Maltose	% Sucrose	% Sorbitol	% Higher DP
Corn Syrup 42/43	81	0	19	14	0	0	67
Brown Rice Syrup 42/43	77		3	45			50
HFCS 42%	71	42	52				6
HFCS 55%	80	55	41				4
Tapioca Syrup 28 DE	79	0	3	13			54
Agave Nectar 76 BRIX	78	71	25				4
Apple Juice Conc - 70 BRIX	66	58	27		13		
Pear Juice Conc. - 70 BRIX	52	53	11		15	21	
Raisin Juice Conc	69	53	47				
Prune Juice	20	26	52		22	0	
Sweet Potato Juice 60 to 62 BRIX	43	9	65	5	19	0	2

Considerations - Function Needed

▶ Flavor

- ▶ Sucrose, dextrose and fructose have different sweetness intensities and characters
- ▶ Fruit or vegetable sources may not deliver a simple (monotonal) sweetness

▶ Mouthfeel/texture

▶ Shelf Life Stability

- ▶ Water Activity Control - smaller molecules preferred

▶ Maillard Browning Reactant

▶ Cost

- ▶ \$1.16 to \$3.50 per pound vs. \$0.35 per pound for HFCS

Annie's Bunny Fruit Snacks

Organic **Tapioca Syrup**, Organic **Pear Juice from Concentrate**, Organic Cane Sugar, Organic Tapioca Syrup Solids, Citrus Pectin, Citric Acid, Natural Flavors, Ascorbic Acid, Organic Sunflower Oil, Organic Carnauba Wax, Colors (Black Carrot, Black Currant Extracts).





Color

Function: Color

- ▶ Benefit of Color-Why can't we just eliminate it from the formula?
 - ▶ Eat with our eyes first
 - ▶ Affects purchase decisions
 - ▶ Can affect how flavor is perceived

Fruit & Vegetable Derived Color Types

▶ Carotenoids

- ▶ Red, Yellow, Green
- ▶ Lipophilic, Moderately Heat Stable, Color lost via oxidation
- ▶ Oranges, Tomato, Carrots, Sweet potato, Red Pepper, Spinach, Kale

▶ Anthocyanins

- ▶ Blue, Purple, Violet, Magenta, Red, Orange
- ▶ Water Soluble, Greatest Stability under Acidic Conditions, Sensitive to Heat and Oxidation
- ▶ Black Carrot, Grape Skin, Red Cabbage, Blueberry, Cranberry

▶ Betacyanins

- ▶ Red, Yellow
- ▶ Water Soluble, Stable between pH 4 and 7. Low Aw Increases Stability
- ▶ Red Beet, Amaranth

Fruit & Vegetable Derived Color Types

▶ Chlorophylls

- ▶ Green, Blue
- ▶ Soluble in Polar Solvents, Heat and Light sensitive
- ▶ Spinach, Kale, other green leafy vegetables, Spirulina (algae)

▶ Caramel Color

- ▶ Caramelized Fruits & Vegetables
 - ▶ Source determines the brown hue
 - ▶ Light colored fruits (apple and pear) used.
 - ▶ Aromatic vegetables used (onion, garlic)
 - ▶ Contributes a source specific flavor in addition to color
 - ▶ Label Simplification: Color and flavor supplied by the same ingredient.

Issues

- ▶ Process
 - ▶ Temperature, pH, Time
- ▶ Storage Temperature/Shelf Life
- ▶ Packaging
 - ▶ Light
 - ▶ Oxygen
- ▶ Oxidizing or Reducing agents
 - ▶ Mineral enrichment
- ▶ Wet or Dry System
 - ▶ Solubility
- ▶ Flavor contribution
- ▶ Cost

Strategies

- ▶ In the development process, don't wait to add color to the formula
- ▶ Understand the chemistry of the selected color(s)
- ▶ Understand the other product ingredients
 - ▶ Interactions
 - ▶ Oxidants or Reducing Agents
- ▶ Understand the process
 - ▶ Where will color be added and what temperatures will it "see"
- ▶ Consider using whole fruit purees or powders if possible
- ▶ Get Help from Packaging
 - ▶ Modified Atmosphere/O₂ Scavenger
 - ▶ Opacity vs. Transparency

Cascadian Farms Fruitful O's

Whole Grain Oat Flour, Sugar, Corn Meal, Oat fiber, Tapioca Syrup, Wheat Starch, Sea Salt, **Color (carrot concentrate, elderberry juice concentrate, annatto, pumpkin concentrate, apple concentrate)**, Fructose, Dextrose, Natural Flavor, Vitamin E (mixed tocopherols) added to preserve freshness.





Texturizers

Texturizers

▶ Functions

▶ Generate Viscosity

- ▶ Ranges from a light body for mouthfeel to a firm gel

▶ Film Forming

▶ Cohesiveness/binding

▶ Stabilizer

- ▶ Emulsion

- ▶ Processing

Fruit & Vegetable Derived Texturizers

▶ Fruit

- ▶ Cell wall comprised of cellulose, lignin, and sometimes pectin.
 - ▶ Fruit fibers, refined (apple, cranberry, blueberry, etc.)
 - ▶ Used for viscosity development
 - ▶ Pectin, extracted & refined
 - ▶ pH and solids considerations
- ▶ Whole Fruit Options
 - ▶ Applesauce and other Fruit Purees
 - ▶ Fat replacement/mouthfeel properties
 - ▶ Humectant/Water Control
 - ▶ Can contribute viscosity
 - ▶ Fruit and Vegetable Powders
 - ▶ Fruit Pieces; dried, freeze dried

Fruit & Vegetable Derived Texturizers

▶ Vegetable

▶ Refined Root Starches

- ▶ Tapioca, Potato, Arrowroot

- ▶ Functional Native Starches available

▶ Vegetable Purees

- ▶ Sweet Potato, Pumpkin

- ▶ Similar function to fruit purees for humectancy, viscosity, fat replacement.

▶ Peas and Beans

- ▶ The legume flours can provide texturizing proteins and functional carbohydrates

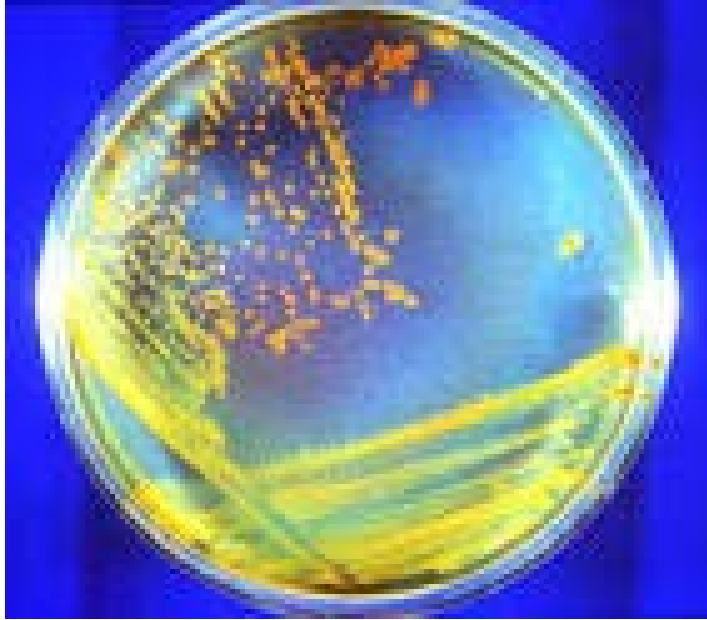
Issues and Strategies

▶ Issues

- ▶ Consistency/Reproducibility: Using a fruit or vegetable based fiber is not like selecting a cellulose gum with a specified viscosity range
- ▶ Color Contribution: Refined fibers and whole fruit purees bring color with them
- ▶ Process Stability: pH, Temperature, and Freeze/Thaw stability
- ▶ Water Activity Balance

▶ Strategies

- ▶ Select fiber sources that compliment the food system color
- ▶ Modify process to accommodate native starches or colored components
- ▶ Use of xanthan gum and other hydrocolloids seems to still be acceptable



Preservatives/Antimicrobials

Antimicrobials

▶ Function

- ▶ Prevent or slow growth of microorganisms/Increase shelf life
 - ▶ Consist of Organic Acids; very effective at concentrations of 100 to 3000 ppm
 - ▶ Un-dissociated acid is active state
 - ▶ pH sensitive - Most effective at low pH (<5.5)
- ▶ Common Synthesized (“Non-Clean”) Forms
 - ▶ Propionic Acid/Calcium Propionate
 - ▶ Sorbic Acid/Potassium Sorbate
 - ▶ Benzoic Acid/Sodium Benzoate
 - ▶ Citric Acid/Sodium Citrate
 - ▶ Lactic Acid/Sodium Lactate
 - ▶ Acetic Acid (vinegar)/Sodium Acetate
 - ▶ Nitric Acid - Nitrates/Nitrites

Antimicrobials-Fruit & Vegetable Sources

- ▶ Propionic Acid
 - ▶ Raisin Juice/Prune Juice Concentrate
 - ▶ Dark color, flavor impact
- ▶ Sorbic Acid
 - ▶ Can be isolated from unripe berries of the rowan tree
 - ▶ Isolate is not commercially available
- ▶ Benzoic Acid
 - ▶ Contained in citrus fruit, pomegranate, plum/prune, cranberries
 - ▶ Fruit derived commercial source not available
- ▶ Citric Acid
 - ▶ Lemons contain 4% to 8%
 - ▶ Other citrus (1% to 3%)

Antimicrobials-Fruit & Vegetable Sources

▶ Lactic Acid/Acetic Acid

- ▶ Produced through fermentation process. Natural preservation method - pickling. Acetic acid enhances effectiveness of many of these

▶ Malic Acid/Tartaric Acid

- ▶ Sourced from many fruits (apples, apricots, avocados, bananas, cherries, grapes/raisins, peaches, pears, passion fruit)
- ▶ Antimicrobial action is limited to pH lowering.

▶ Nitrate

- ▶ Sourced from celery, beets, carrots, spinach and other vegetable juices.
- ▶ Either pre-converted through fermentation to nitrite or can add reducing agent to formulation.

Issues and Strategies

- ▶ Effectiveness
 - ▶ Higher usage levels required
 - ▶ Flavor and/or color issues
 - ▶ More effective when combined with acetic acid (vinegar)
 - ▶ Shot gun approach to selecting antimicrobial system
 - ▶ Hurdle Technology
 - ▶ Aw, MAP Packaging, Pasteurization/Retort Processing
- ▶ Cost
 - ▶ Higher than “chemical” salts
- ▶ Shelf Life and Distribution
 - ▶ Move from ambient to refrigerated distribution
 - ▶ Shorten shelf life

Nature's Rancher Uncured Beef Hot Dogs

Beef, Water, contains less than 2% of the following: Sea Salt, Honey, Evaporated Cane Juice, Mustard, Nutmeg, Pepper, Allspice, Ginger, Paprika, Onion Powder, Garlic Powder, **Celery Juice Powder**, Lactic Acid Starter culture.





Fortification

Fortification/Nutrition

▶ Function

- ▶ Improve vitamin content of food
- ▶ Replace vitamins lost in processing
- ▶ Increase anti-oxidant level
- ▶ Provide servings of fruit and/or vegetables

Fortification/Nutrition

- ▶ Individual Fruit and Vegetable Powders
 - ▶ Standardized
 - ▶ Provide “Actives” specific to each source
 - ▶ Carrot powder delivers 1200 IU/g Beta Carotene
 - ▶ Cranberry powder delivers
 - ▶ 6% Quinic Acid
 - ▶ 2% on average OPC (Pre-anthocyanins)
 - ▶ 0.6% Total Anthocyanins
- ▶ Fruit and Vegetable Blends
 - ▶ Deliver 25% to 50% of the RDI for Vitamins A,C,D,E, B1, B2

Mango Crèmes with NutriFusion

Enriched Wheat Flour (wheat flour, niacin, reduced iron, thiamine mononitrite, riboflavin, folic acid), sugar, palm oil, dextrose. Contains less than 2% of the following: Corn Syrup, Leavening (ammonium bicarbonate, baking soda, mono-calcium phosphate), Natural and Artificial Flavors, corn starch, salt, coconut, **Nutrients from Natural Whole Food Concentrate (cranberry, pomegranate, orange, grape, strawberry, shitake mushroom)**, soy lecithin, citric acid, malic acid, annatto color.



SWEET

UMAMI

SALTY

SOUR

BITTER

Flavor

Function of Flavor

- ▶ The most critical driver of product liking
 - ▶ If it doesn't taste good re-purchase is unlikely
- ▶ Stimulates Appetite
 - ▶ Prepares the digestive system to receive nutrition (“mouthwatering”)
 - ▶ People who are unable to smell and/or taste have difficulty maintain a healthy body weight because they are not interested in eating.
- ▶ Provides a sense of adventure—seeking out new and interesting flavors
 - ▶ Makes eating a pleasurable experience

Flavor Trends

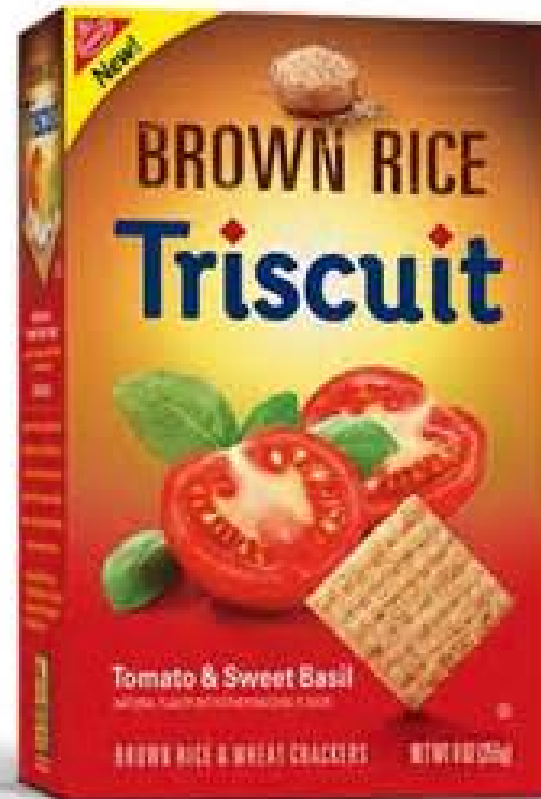
▶ Trends around Fruit and Vegetables

- ▶ Fresh Puree's and Juices are seen more frequently.
 - ▶ Blended with bold spices and herbs to create sauces and dressings
 - ▶ Fruit/Vegetable Smoothies
 - ▶ Multiple juice blends
- ▶ Vegetables as a source of Umami
 - ▶ Tomato, Mushroom, Sweet Potatoes
 - ▶ Powders and juices contributing flavor to crackers, chips, etc.
- ▶ Citrus
 - ▶ Adding acidity contributes to a depth of flavor and a refreshing taste.

Issues and Strategies

- ▶ Issues are similar to those seen with the other function groups
 - ▶ Use Level is higher for similar flavor intensity
 - ▶ Flavor Stability may be shorter
 - ▶ Processing Limitations
 - ▶ Cost
- ▶ Strategies
 - ▶ Define what is most important about the product
 - ▶ Optimize your formula
 - ▶ Take advantage of whole fruit solutions that provide flavor, color, texture and nutrition in one ingredient!

Flavor Examples



In Summary

- ▶ Several fruit and vegetable derived ingredients are available for clean label formulation.
- ▶ There are gaps in some functional areas.
 - ▶ Antimicrobials
 - ▶ Possible opportunities for the supplier community
- ▶ Formulating requires a different approach—not a simple substitution.
- ▶ Many tools available for interesting and creative product development!

Thank You for your Attention



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