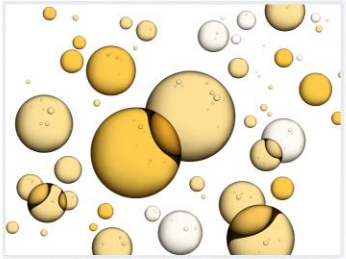
Colors From Nature™

- ADM is a market leader in innovation for colors from natural sources
- Most comprehensive range of colors from natural sources
- Naturally-derived acid stable blue and green colors
- Global color support
- Color forms include liquid, dry blends, emulsions, dispersion and spray dry

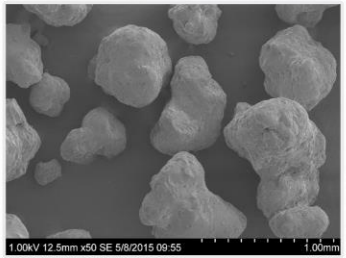
Delivery Systems Customized To Address Desired Benefits

- Leverage emulsion and particle science
- Solubility in the right matrix
- Heat stability
- Particle size customization
- Controlled release (encapsulation)
- Shelf-life stability

Liquid Delivery



Solid Delivery



Consumer Acceptance of Natural Colors

Snapshot

- Natural color market is growing at 6.1% CAGR & projected to be $2.3 Billion by 2020

Growth Drivers

- Increasing demand for clean label food products, especially for children
- Consumer preference to buy natural food products
- 61% of global consumers and 50% of North Americans are avoiding artificial colors, mostly due to health concerns
- Growing number of government approvals of natural colors
- Improvements on stability and solubility of natural food colors

Growth Restraints

- High prices, especially in an environment where Cost Control doubled in importance for R&D efforts between 2016 to 2018
- Supply chain issues
- Continued stability and solubility issues of natural food colors
- Vibrancy of natural colors

Source: Future Market Insights, 2015
Food Processing Survey, 2018
Nielsen, 2018

Consumer Acceptance of Natural Colors

Consumer demands resulting in large Consumer Goods Packaging companies to announce reformulation plans to ease stakeholders' concerns

Kraft

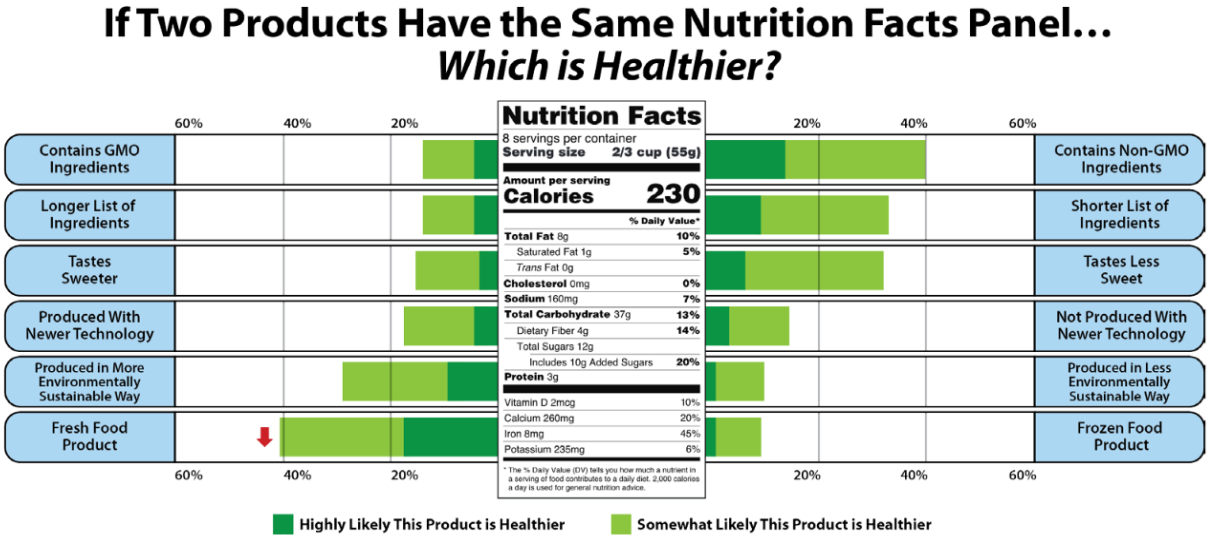
MARS

GENERAL MILLS

Mondelēz International

Nestlé

Consumer Acceptance of Natural Colors: Impact of Ingredients



GMO's, longer ingredient lists, sustainable production and freshness influence healthy perception

Source: 2018 IFIC Health & Wellness Survey

Consumer Acceptance of Natural Colors: Impact of Ingredients

- Consumer Package Goods Manufacturers are listening…Ingredients being added or removed in 2018[1]

Removing GMO ingredients	34%
Adding Fruits & Vegetables	21%
Replacing Synthetic Colors	22%

- Non-GMO claims have grown the most, with 15.7% of new products launched in 2015 making Non-GMO claims vs 10.2% in 2014 and only 2.8% in 2012[2]

Source: [1]Food Processing Survey, 2018
[2]Nielsen, 2016

Consumer Acceptance of Natural Colors: Case Study

- Look, flavor and smell are nostalgic & iconic
  - We taste with our eyes
- Issue: couldn't replicate the vibrant red and neon blue-green corn puffs with fruit and vegetable juices
  - "My kids find the color of the new Trix cereal quite depressing"
  - "My childhood fading away with the colors of Trix cereal"
  - Besides producing a bland color, the juices and extracts gave the cereal a different taste

"Silly Rabbit, Trix are for kids"

Reference: Wall Street Journal, Sept. 22, 2017

Consumer Acceptance of Natural Colors: Only Thing Constant Is Change

“Starbucks Ditches Bug-Based Red Dye In Strawberry Drink”

NPR: April 19, 2012

“Farming The Next Big Food Source: Crickets”

Forbes: Jan 30, 2018

Regulatory Challenges of Natural Colors: Non-Conformity in Global Regulations

Allowed | Highly Regulated | Not Listed | Not Allowed

Natural Food Colour/ Region	North America			Western Europe					
	U.S.	Canada	Mexico	U.K.	Germany	France	Italy	Spain	Nordic
Natural Beta-carotene	○	○	○	○	○	○	○	○	○
Lycopene	○	○	○	✓	✓	✓	✓	✓	✓
Lutein	✓	✓	✓	○	○	○	○	○	○
Annatto	○	○	○	○	○	○	○	○	○
Curcumin	○	○	○	○	○	○	○	○	○
Anthocyanin	○	○	○	○	○	○	○	○	○
Paprika Extract	○	○	○	○	○	○	○	○	○
Spirulina Extract	✓	✓	✓	○	○	○	○	○	✗
Chlorophyll	✓	✓	✓	○	○	○	○	○	○
Carmine/ Cochineal Extract	✓	✓	✓	○	○	○	○	○	⊘
Betanin/Betalain	○	○	○	○	○	○	○	○	○
Safflower	⊘	⊘	⊘	○	○	○	○	○	○
Astaxanthin Extract	✓	✓	✓	✓	✓	✓	✓	✓	⊘

Source: Future Market Insights, 2015

Regulatory Challenges of Natural Colors

- USA Color Additive Fruit/Vegetable Juice: Expressing the juice from mature varieties of fresh, edible fruits/vegetables, or by the water infusion of the dried fruit
- For Non-Traditional sources: Demonstrated safety of consuming fruit over an extended period of time (≈20 years) & with a relatively large, geographically diverse population
  - If not, must file a Color Additive Petition (5+ years; $5+ Million in testing)
- Natural Colors have less available regulatory avenues
  - Colors are controlled more strictly than other food additives
  - Self-GRAS
    - Letter Of No Objection
    - FEMA
  - Opportunity for IACM?

Source: 21 CFR: 73.250 Fruit juice

Technical Challenges of Natural Colors

- Stability: Cannot modify color structure or remove unstable compounds through selective extraction without applying for Color Additive Petition (CAP)
  - Ex: Increase stability of anthocyanins by adding acyl groups via enzyme not allowed
- Taste: Selective extraction to purify the color with membrane technology (UF, RO, FO) or column chromatography not allowed without CAP
- Enzymes used in juice processing to improve yields and appearance
  - Allowed in producing Natural Colors from juices??
  - Substantially equivalent vs. unique specifications
- Emulsifiers and Chemical Preservatives
  - Anyone for Polyglycerol Polyricinoleate (PGPR)?
  - Clean label concerns
  - May negate “no artificial ingredients” claim

Technical Challenges of Natural Colors

- Fermentation of the Color
  - Ex: Stability of red wine's color
  - Ex: Removing sugar via fermentation to reduce browning during baking
- Bioconversion
  - Traditional breeding programs: May lead to an issue with EU's Colouring Foods Reg
  - Genetic engineering
    - Exogenous DNA vs. Non-Exogenous DNA
    - Mutagenesis
    - Labeling: Different regulations in different regions