Going Au Naturel—
Coloring Considerations

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CLEAN LABEL CONFERENCE

www.GlobalFoodForums.com/CleanLabel

What are “natural” colorants?

Neither FDA or EU has a legal definition for “natural” colorants

However, consumers & marketing departments have a clear concept of “natural” & artificial colorants

FDA Colorants Classification

Certified colorants— Synthetic FD&C food dyes for which each manufactured batch must be tested by FDA labs

Color additives for food use that are exempt from certification (Most are naturally derived, n = 35)

Growth market for “natural” colorants

Global sales of “natural” colorants have overtaken artificial colorants*

Consumer concern over safety of artificial colorants

Many “natural” colorants provide health benefits

*Mintel & Leatherhead Food Research, 2013

Impact of the Southhampton Study

Effect of synthetic food colorant consumption by 3 yr-old & 8-9 yr old children on hyperactivity

Concluded that the Global Hyperactivity Aggregate (GHA) score was higher

European Food Safety Authority concluded that the Acceptable Daily Intake (ADI) should not be changed

Food Advisory Committee of FDA reviewed issue, FDA took no action

McCann et al., 2001

Functionality of “Natural” Colorants

Less stable to heat, light & O_2

May react with other components to produce undesirable flavors & colors

All desired hues may not be possible

“Natural” are more costly

The “Ideal” Natural Colorant*

Permitted for use in all markets

No impact on product appearance or flavor

No change in nutritional profile

No change in shelf life or stability

No change in manufacturing processes

No change to product packaging

No change to ingredient cost

*Thanks to Cathy Culver, Pepsico

The Real World*

- No global consensus on regulations
- Matching appearance is challenging
- Flavor profile often changes
- Usually less stable
- Processing & packaging my have to change
- Cost will increase

* Cathy Culver, Pepsico

What are some alternatives to those artificial AZO dyes?

?

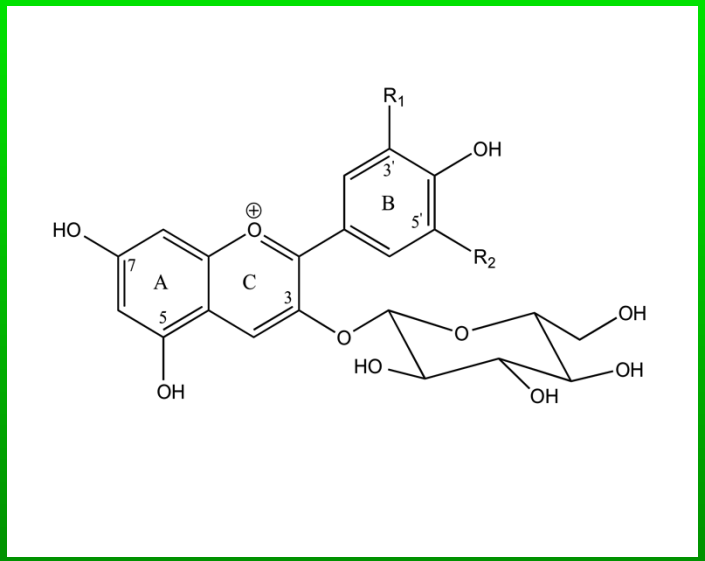
For red hues…
Anthocyanin-based Colorants

USA– Fruit & Vegetable juices, Grape-skin, Grape Color

Europe— E 163

Structure variation impacts hue and stability

Suitable for pH < 4.0



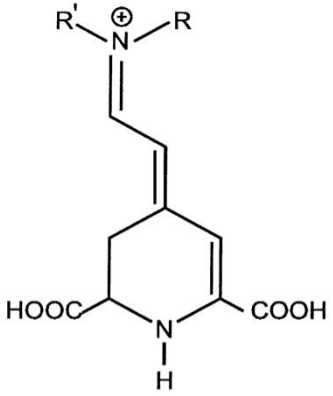
Properties of Anthocyanin-based Colorants

	Hue	pH range	Stability
Grape-skin extract	red-purple	<3.5	fair-good
Red grape juice	red-purple	<3.5	fair-good
Black carrot	red-purple	<4.5	good-excellent
Red radish	red	<4.5	good-excellent
Purple Sweet Potato	red-purple	<4.5	good-excellent
Purple corn	red-purple	<4.5	good

Betalain Pigments

Source: Beet powder & Beet Juice

- Express red color throughout the pH range of foods
- Water-soluble (greater H_2O-solubility than anthocyanins)
- Very unstable to light & heat
- “Earthy” flavors can be problematic
- Suitable for frozen desserts



Generalized structure for betalains

Cochineal & Carmine

H_2O/EtOH extract of female cochineal insect *Dactylopius coccus* costa

Carmine is the Ca-AL lake of carminic acid

Extremely stable to light, heat, & oxidation

Relatively high-cost and non-kosher

Tomato Lycopene Extract

H_2O-insoluble

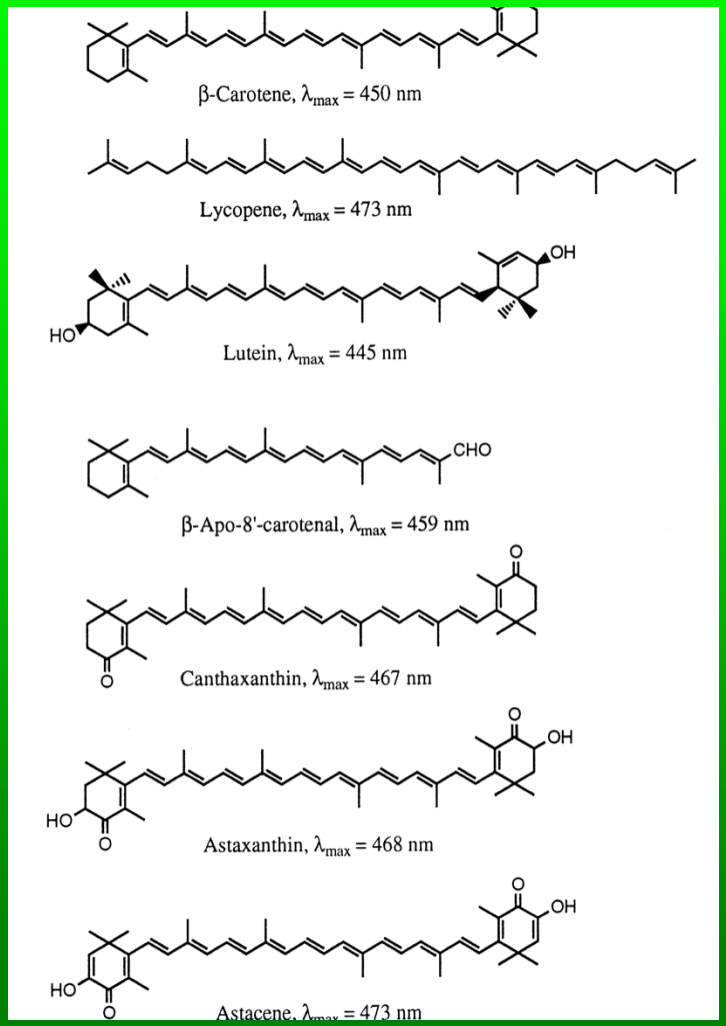
Oleoresins, powders & H_2O-dispersible preparations commercially available

Yellow —> Orange —> Red hues

Susceptible to oxidation

Stable through broad pH range

Carotenoids… for yellow to orange hues



Lipid soluble

Susceptible to oxidation

Some H_2O-dispersible preparations have small particle size that approaches visual clarity

Properties of Carotenoid-based Colorants

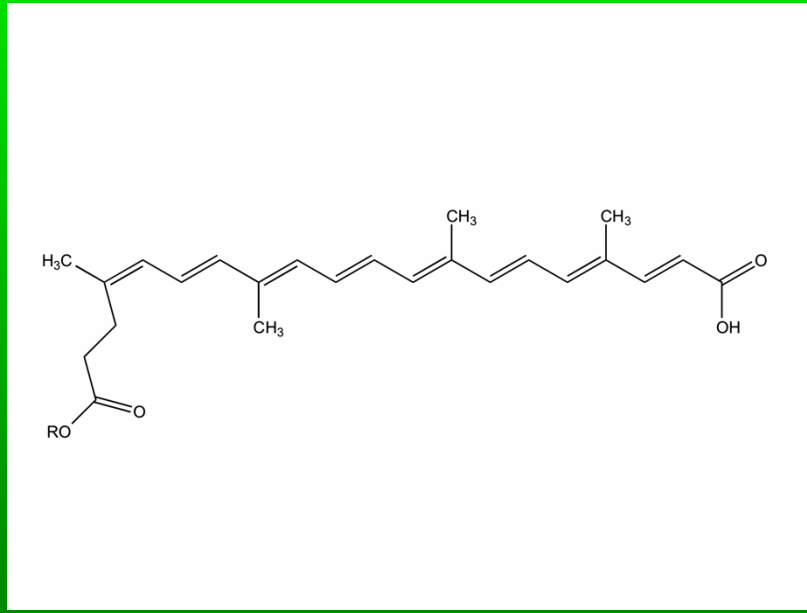
	Hue	pH range	Stability
Annatto	Yellow to orange	3.0-8	Fair-good
β-Apo-8'-carotenal	Orange	3.0-8	Fair-good
Astaxanthin (fish feed)	Orange-red	3.0-8	Fair-good
Canthaxanthin	Orange-red	3.0-8	Fair-good
β-Carotene	Yellow-orange	3.0-8	Fair-good
Corn Endosperm Oil (chicken feed)	Yellow		Fair-good

Annatto

Extract of date palm seed

Bixin, (R = CH_3) & Norbixin,(R = H)

Both H_20 & Lipid-dispersible preps are available



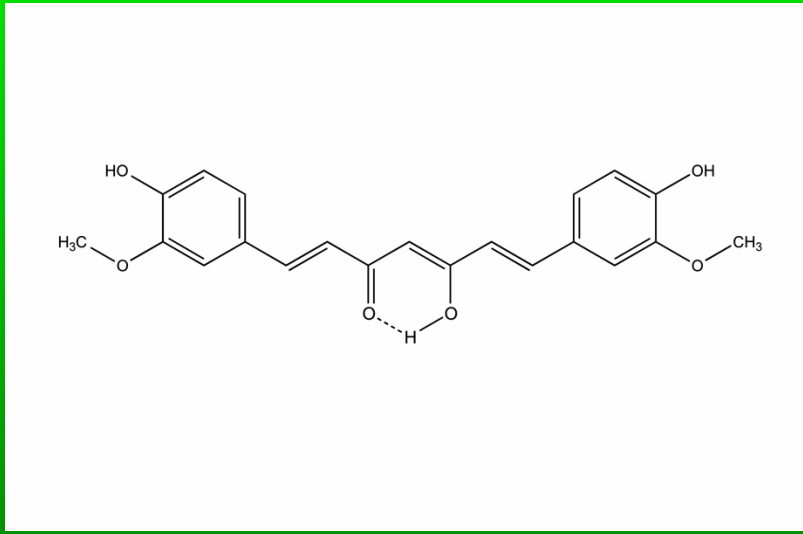
Tumeric & Tumeric Oleoresin

Source: Rhizomes of *Curcuma longa*

Spice giving characteristic color & flavor to mustard, pickles, curry powder

Unstable to light; susceptible to oxidation

Anti-carcinogen, anti-inflammatory



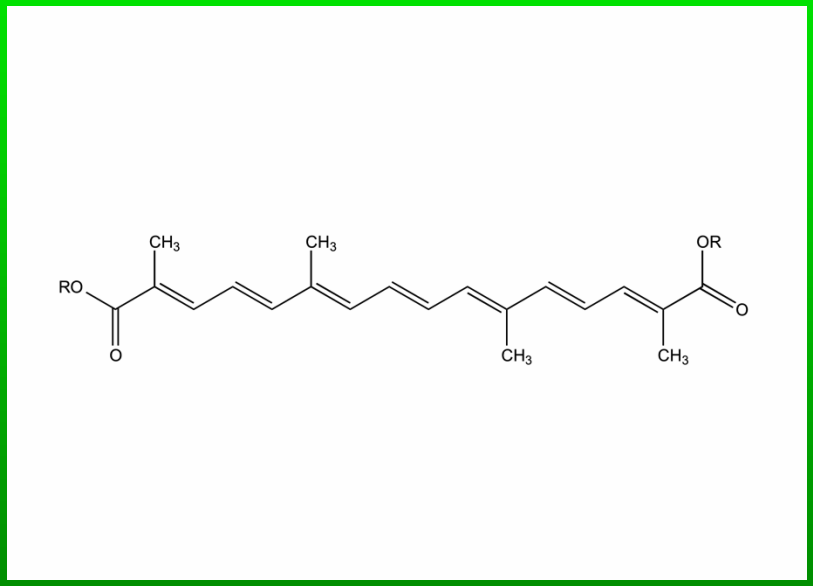
Saffron— Intense Yellow Pigment

Crocin, R = gentiobiose

Source: Dried stigma of Crocus sativus flowers

Stable to light & heat

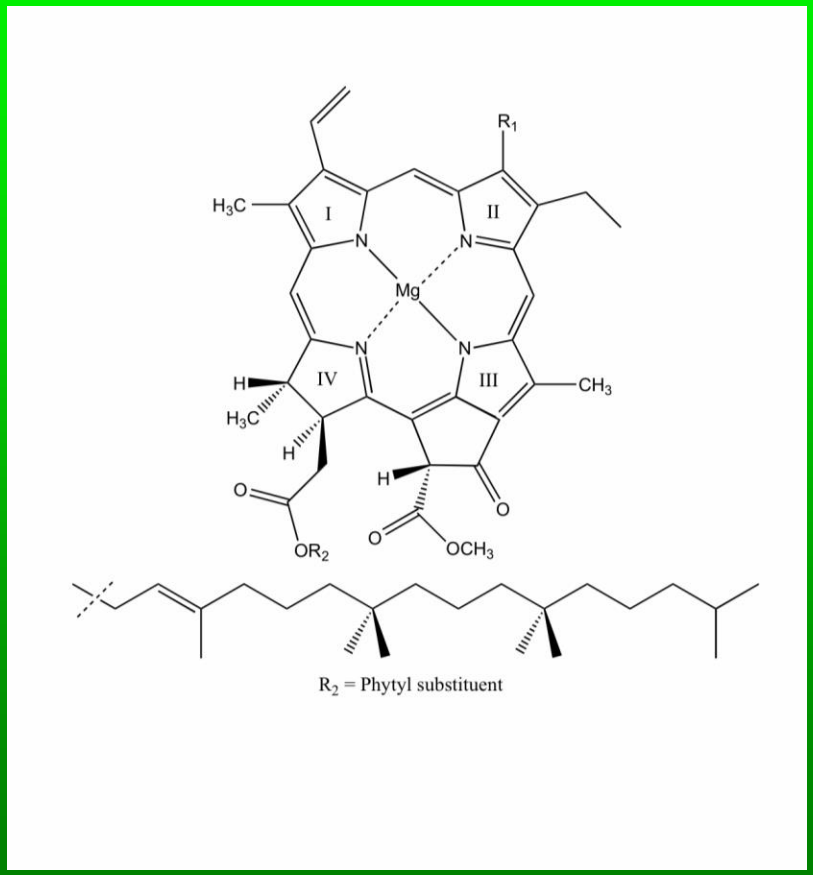
$— Very expensive



Chlorophyll… for green hues

Na-Cu Chlorophyllin approved in USA for dry-mix beverages

Cu chlorophyllin & Cu chlorophyll complexes approved for wide usage in EU

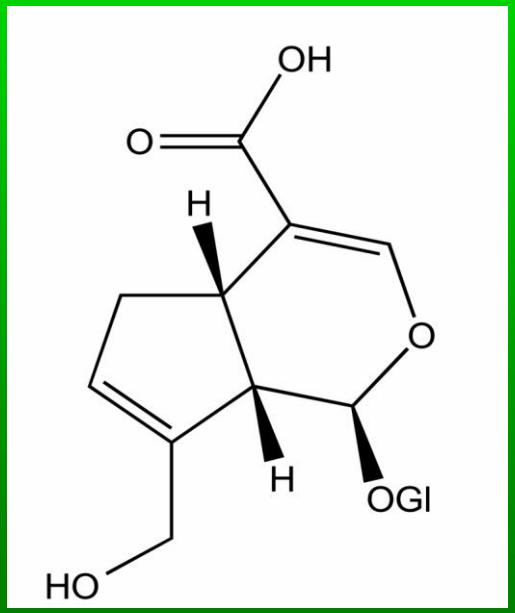


Blue…very limited options

Iradoid pigments— Geniposides become blue with exposure to glycosidases & amino acids in presence of oxygen

Sources:

- Amazonia Huito fruit
- Gardenia (restricted to Japan)



Spirulina Extract – A New Blue

H_2O extract of cyanobacterea *Arthrospira platensis*

Phycobillin photosynthetic pigment (phycocyanins)

Approved for confections & chewing gum

Caramel Colorants… for brown color

Manufactured via Maillard Reaction– sugars + acids/alkalis + ammonium & sulfite compounds

H_20-soluble, amber —> reddish brown —> dark brown

Differ in colloidal charge

Preparations for soft drinks, alcoholic beverages

Account for 90% by weight of all colorants produced

Black & White

EU permits vegetable carbon black

Carbon black delisted in USA; replaced by adding a combination of all colorants

TiO_2 used as whitening agent in confectionary baked goods, dairy products

“Natural Colorants”
Not a stock commodity…

The same colorant can vary in price…

… and also vary in purity, tinctorial strength, shade of color, presence of unwanted flavors, stability to heat and light, tendency to precipitate, and suitability for individual applications

Looking ahead- What's on the horizon?

New sources— Edible plants with high pigment content, desirable hues, good stability.

Plant breeding, traditional vs. GMO. Patents vs. proprietary

Tissue culture?

Improved processing technologies

- Enzymes as processing aids to increase recovery
- Filtration & microfiltration technologies
- Micro-encapsulation for stability and protection from oxidation
- More efficient evaporators and dryers
- Resin treatments, membrane processes for flavor removal & pigment concentration

Improved Extraction Technologies

Supercritical extraction with CO_2

Pressurized liquid extraction

Microwave-assisted extraction

Ultrasound-assisted extraction

Ohmic heating-assisted extraction

Continuous counter-current extraction

Solid-phase extraction

Microextraction

Adulteration of “Natural” Colorants

Are a high-value item

High-price + limited availabilty —>

Temptation for cheating in the marketplace

Key Reference

RE Wrolstad & CE Culver. 2012. Alternatives to those artificial FD&C food colorants*. Annu. Rev. Food Sci. Technol*. 2012. 3:59-77.

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Questions ?

Comments?