WELCOME TO THE WEBINAR:
The Challenge of Formulating with Natural Colors

Hosted by the PMCA Research Committee
Eric Schmoyer, Barry Callebaut – Chair

Presenters:
Michael Jelavich, Sensient Colors
Pam Gesford, The Hershey Company
Sarah Codrea, IACM (International Association of Color Manufacturers)

Additional Content Contributor:
Nigel Sanders, Smart Confectionery Solutions

Webinar Organizer:
Yvette Thomas, PMCA

Webinar Co-organizer:
Rachel Halkias, PMCA
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Let’s get started!
Overview

- Basics of Food Colors
- Applications
- Food Color Regulations
Where Does Color Originate?

- Light from the Sun appears colorless, sometimes referred to as “white light”.
- White light contains all the colors of the rainbow.
- The wavelengths of light can be separated with a prism.
Basics of Food Colors

- Incident
- Reflected
- Absorbed
- Transmitted
Basics of Food Colors

Light Source Affects Color Perception
Basics of Food Colors

Color of Your Base Material Affects Final Shade

Base

Blue

Pink
Synthetic Colors
Dyes

- Water Soluble
- Selectively Absorb Wavelengths of Light
- The transmitted light is perceived as color to our eyes
- Dyes cause products to appear darker since they limit the amount of light which reaches our eyes
Synthetic Colors

Lakes

• Lakes are pigments, and are water and oil dispersible
• Used in products where color migration or bleed is not desired
• Lakes are dispersed throughout the product, not dissolved
• The lake pigment absorbs specific wavelengths of light and reflects others
• Lakes scatter light, contributing to opacity
Natural Colorants
<table>
<thead>
<tr>
<th>Color</th>
<th>Shade</th>
<th>Forms</th>
<th>Stability</th>
<th>Color in Candy</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Turmeric</em> <em>(Oil Soluble)</em> <em>(Water Dispersible)</em></td>
<td>Yellow</td>
<td>Powder Dispersion Oleoresin</td>
<td>Heat pH below 6.5 Poor light</td>
<td>![Color Swatch]</td>
</tr>
<tr>
<td><em>Beta-Carotene</em> <em>(Oil Soluble)</em> <em>(Water Dispersible)</em></td>
<td>Yellow Orange</td>
<td>Powder Dispersion</td>
<td>Heat pH Light Poor Oxidation</td>
<td>![Color Swatch]</td>
</tr>
<tr>
<td><em>Paprika</em> <em>(Oil Soluble)</em> <em>(Water Dispersible)</em></td>
<td>Orange Red</td>
<td>Powder Dispersion Oleoresin</td>
<td>Heat Light pH Poor Oxidation</td>
<td>![Color Swatch]</td>
</tr>
<tr>
<td><em>Annatto</em> <em>(Bixin - Oil Soluble)</em> <em>(Norbixin – Water Soluble)</em></td>
<td>Yellow Gold</td>
<td>Powder Dispersion</td>
<td>Light Acid Proof Form Fair Heat Fair Oxidation</td>
<td>![Color Swatch]</td>
</tr>
<tr>
<td><em>Anthocyanins</em> <em>(Water Soluble)</em> <em>(Can be made into Oil Dispersible)</em></td>
<td>Pink Red Purple Blue</td>
<td>Powder Liquid</td>
<td>Heat Light pH changes color</td>
<td>![Color Swatch]</td>
</tr>
<tr>
<td><em>Carmine</em> <em>(Oil and water dispersible)</em></td>
<td>Pink Red Purple</td>
<td>Powder Dispersion Liquid</td>
<td>Heat pH above 3.5 Light</td>
<td>![Color Swatch]</td>
</tr>
<tr>
<td>Color (Solubility)</td>
<td>Shade</td>
<td>Forms</td>
<td>Stability</td>
<td>Color in Candy</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------</td>
<td>------------------------</td>
<td>--------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Beet (Water Soluble) (Can be made into Oil Dispersible)</td>
<td>Pink Purple Red</td>
<td>Powder Liquid Dispersion</td>
<td>Fair Heat Light Oxidation pH 3.5-5.5</td>
<td><img src="image1" alt="Beet" /></td>
</tr>
<tr>
<td>Spirulina (Water Soluble) (Can be made into Oil Dispersible)</td>
<td>Blue</td>
<td>Powder Dispersion</td>
<td>Light Oxidation Below 45°C pH 4-7</td>
<td><img src="image2" alt="Spirulina" /></td>
</tr>
<tr>
<td>Chlorophyll Chlorophyllin (Chlorophyll - Oil Soluble) (Chlorophyllin – Water Soluble)</td>
<td>Green</td>
<td>Powder Dispersion Oleoresin</td>
<td>Heat Light pH</td>
<td><img src="image3" alt="Chlorophyll" /></td>
</tr>
<tr>
<td>Caramel (Water Soluble) (Can be made into Oil Dispersible)</td>
<td>Brown</td>
<td>Powder Dispersion</td>
<td>Light Acid Proof Form Fair Heat Fair Oxidation</td>
<td><img src="image4" alt="Caramel" /></td>
</tr>
<tr>
<td>Oxides (Oil and water dispersible)</td>
<td>Red Black Yellow White</td>
<td>Powder Liquid</td>
<td>Heat Light pH above 3.5 Light</td>
<td><img src="image5" alt="Oxides" /></td>
</tr>
<tr>
<td>Vegetable Carbon (Oil and water dispersible)</td>
<td>Black</td>
<td>Powder Dispersion Liquid</td>
<td>Heat pH above 3.5 Light</td>
<td><img src="image6" alt="Vegetable Carbon" /></td>
</tr>
</tbody>
</table>
Cost Differences

• CIU has declined from new advances in technologies & techniques
• In General
  • Natural colors are more expensive than synthetic colors, but are not cost prohibitive
  • Oxides are less expensive than synthetic colors
  • Nature Identical Colors are less expensive than Nature Derived
  • Color delivery systems (such as dispersions and emulsions) can reduce the cost-in-use of colors
• Examples of Usage Rates
  • Hard Panning
    • FD&C Blue No 1 Lake: 2.0-3.0% in coating syrup
    • Spirulina Power: 1.0-2.0% in coating syrup
  • Gummies
    • FD&C Red No. 40 Dye: 0.025%-0.05%
    • Red Cabbage (anthocyanin): 0.15-0.30%
Supply Chain

• Nature Derived colors are harvested from farms
• Most of the larger color companies have vast supply chains which can supply colors large enough for the biggest of brands
• Be sure to speak with your color vendor about their natural color volume capabilities
# Natural Color Selection

<table>
<thead>
<tr>
<th>Natural Color Selection</th>
<th>Delivery Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Water Soluble or Water Dispersible</td>
<td>- Sugar Based</td>
</tr>
<tr>
<td>- Moderate to Great Heat Stability</td>
<td>- Aqueous Dispersions</td>
</tr>
<tr>
<td>- Coating Syrup pH</td>
<td>- Liquid Colors</td>
</tr>
</tbody>
</table>

## Natural Color Selection Delivery Methods

- Sugar Based
- Aqueous Dispersions
- Liquid Colors
- Powders
- Rice matrix pigments

### Reds
- o Carmine
- o Iron Oxide
- o Anthocyanins

### Oranges
- o β-Carotene
- o Paprika

### Yellows
- o Turmeric
- o Riboflavin
- o β-Carotene

### Greens
- o Mixture of Blues & Yellows

### Blues
- o Anthocyanins
- o Spirulina

### Violets
- o Anthocyanins
- o Mixtures of Blues and Reds
- o Carmine

### Blacks
- o Vegetable Carbon
- o Iron Oxide
- o Caramel

### Whites
- o Titanium Dioxide
- o Opacifying Agents
# Hard Panning

## Common Concerns/Issues

- Poor Sealing and Drying
- Temperature/pH/hold time of Syrup
- Brix of Syrup
- Achieving an opaque base layer
- Rework or additional layers

## Possible Controls/Solutions

- Ensure center is sealed well
- Ensure grossing shell is opaque/smooth
- Use heat stable colors for high brix applications
- Minimize inversion in syrup for proper drying (for sucrose)
- Control drying air…. Flow rate, time applied, humidity
## Hard Candy

<table>
<thead>
<tr>
<th>Natural Color Selection</th>
<th>Delivery Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Water Soluble or Dispersible Colors</td>
<td>• Liquid Colors</td>
</tr>
<tr>
<td>• Great Heat Stability</td>
<td>• Propylene Glycol</td>
</tr>
<tr>
<td>• pH Stability</td>
<td>• Glycerin</td>
</tr>
<tr>
<td>• Acids/Flavors Used</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Red</th>
<th>Orange</th>
<th>Yellow</th>
<th>Green</th>
</tr>
</thead>
<tbody>
<tr>
<td>o Lycopene</td>
<td>o β-Carotene</td>
<td>o Turmeric</td>
<td>o Mixture of Blues &amp; Yellows</td>
</tr>
<tr>
<td>o Iron Oxide</td>
<td>o Paprika</td>
<td>o Riboflavin</td>
<td></td>
</tr>
<tr>
<td>o Anthocyanins</td>
<td>o Canthaxanthin</td>
<td>o β-Carotene</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Blue</th>
<th>Violet</th>
<th>Black</th>
<th>White</th>
</tr>
</thead>
<tbody>
<tr>
<td>o Anthocyanins</td>
<td>o Anthocyanins</td>
<td>o Vegetable Carbon</td>
<td>o Titanium Dioxide</td>
</tr>
<tr>
<td></td>
<td>o Mixtures of Blues and Reds</td>
<td>o Iron Oxide</td>
<td>o Opacifying Agents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Caramel</td>
<td></td>
</tr>
</tbody>
</table>

**Natural Color Selection**

- Water Soluble or Dispersible Colors
- Great Heat Stability
- pH Stability
- Acids/Flavors Used

**Delivery Methods**

- Liquid Colors
- Propylene Glycol
- Glycerin
# Hard Candy

## Common Concerns/Issues

- Heat
- Added moisture
- Light stability
- Acids/Flavors Used
- Flavor Off Notes

## Possible Controls/Solutions

- Use flavors/acids which do not adversely affect color
- Add heat sensitive colors after cooking
- Protect product from light exposure if less light stable colors are required for desired shade

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- **Too Much Moisture**
- **Beet added at 100°C and 145°C**
- **Flavor variations**
# Gummies/Gels

## Natural Color Selection
- Water Soluble or Water Dispersible Colors
- Moderate or Greater Heat Stability
- pH compatible with flavoring systems

## Delivery Methods
- Glycerin
- Propylene Glycol
- Liquid Colors
- Powders

## Color Selection

<table>
<thead>
<tr>
<th>Reds</th>
<th>Oranges</th>
<th>Yellows</th>
<th>Greens</th>
</tr>
</thead>
</table>
| o Carmine  
o Iron Oxide  
o Anthocyanins | o β-Carotene  
o Paprika  
o Canthaxanthin | o Turmeric  
o Riboflavin  
o β-Carotene | o Mixture of Blues & Yellows |

<table>
<thead>
<tr>
<th>Blues</th>
<th>Violets</th>
<th>Blacks</th>
<th>Whites</th>
</tr>
</thead>
</table>
| o Anthocyanins  
o Spirulina | o Anthocyanins  
o Mixtures of Blues and Reds | o Vegetable Carbon  
o Iron Oxide  
o Caramel | o Titanium Dioxide |
# Gummies/Gels

## Common Concerns/Issues

- Heat
- Flavor Off Notes
- Light stability
- pH (especially when specific one is needed for proper set)
- Vitamin/neutraceuticals

## Possible Controls/Solutions

- Speak with color vendor about all vitamins/nutraceuticals used
- Add heat sensitive colors after gelatin is solubilized
- Use opaque packaging for light sensitive colors and protection for WIP
- Consider alternate gel agent (LM pectin versus HM for blue/purple shades)

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Vitamin C Attacking Anthocyanins Overtime

Light Stability of Turmeric Over 24 hours
## Compound Coatings/ Fat Based Fillings

<table>
<thead>
<tr>
<th>Natural Color Selection</th>
<th>Delivery Methods</th>
</tr>
</thead>
</table>
| • Oil soluble or oil dispersible colors  
• Emulsions  
• Moderate Heat Stability | • Oil  
• WO emulsion  
• Powders  
• Rice matrix pigments |

<table>
<thead>
<tr>
<th>Reds</th>
<th>Oranges</th>
<th>Yellows</th>
<th>Greens</th>
</tr>
</thead>
</table>
| o Iron Oxide  
o Anthocyanins  
o Carmine | o β-Carotene  
o Paprika  
o Annatto | o Turmeric  
o Riboflavin  
o β-Carotene | o Mixture of Blues & Yellows |

<table>
<thead>
<tr>
<th>Blues</th>
<th>Violets</th>
<th>Blacks</th>
<th>Whites</th>
</tr>
</thead>
</table>
| o Anthocyanins  
o Spirulina | o Anthocyanins  
o Mixtures of Blues and Reds  
o Carmine | o Vegetable Carbon  
o Iron Oxide  
o Caramel | o Titanium Dioxide |
# Compound Coatings/Fat Based Fillings

## Common Concerns/Issues

- Heat
- Flavor Off Notes
- pH
- Acids/Flavors Used
- Light stability

## Possible Controls/Solutions

- Use opaque packaging for light sensitive colors
- Introduce heat sensitive colors while product is cooling
- Use suitable oils/emulsifiers for emulsions and dispersions

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Too Much Heat Applied

Poor Emulsion Used
# Compressed Tablets

<table>
<thead>
<tr>
<th>Natural Color Selection</th>
<th>Delivery Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Plating-grade colors</td>
<td>• Powders</td>
</tr>
<tr>
<td>• Moderate to great heat stability</td>
<td>• Rice matrix pigments</td>
</tr>
<tr>
<td>• Interaction with flavoring system</td>
<td></td>
</tr>
<tr>
<td>• Light stable colorants dependent on packaging</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reds</th>
<th>Oranges</th>
<th>Yellows</th>
<th>Greens</th>
</tr>
</thead>
<tbody>
<tr>
<td>o Carmine</td>
<td>o β-Carotene</td>
<td>o Turmeric</td>
<td>o Mixture of Blues &amp; Yellows</td>
</tr>
<tr>
<td>o Anthocyanins</td>
<td>o Paprika</td>
<td>o Riboflavin</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Annatto</td>
<td>o β-Carotene</td>
<td></td>
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<td></td>
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<th>Blues</th>
<th>Violets</th>
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<th>Whites</th>
</tr>
</thead>
<tbody>
<tr>
<td>o Anthocyanins</td>
<td>o Anthocyanins</td>
<td>o Vegetable Carbon</td>
<td>o N/A</td>
</tr>
<tr>
<td>o Spirulina</td>
<td>o Mixtures of Blues and Reds</td>
<td>o Caramel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Carmine</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Compressed Tablets

## Common Concerns/Issues

- Pressure used in compression
- Acids/Flavors Used
- Flavor Off Notes
- Light Stability
- Base particle size

## Possible Controls/Solutions

- Use opaque packaging for light sensitive colors
- Use flavors/acids which do not adversely affect color
- Change base particle size to minimize color usage

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**Strength Increases With Increasing Particles Size**

**Non-Plating Grade Vs Plating Grade Beet**
# Marshmallows

## Natural Color Selection

<table>
<thead>
<tr>
<th>Colors</th>
<th>Natural Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blues</td>
<td>Anthocyanins</td>
</tr>
<tr>
<td></td>
<td>Spriulina</td>
</tr>
<tr>
<td>Blacks</td>
<td>Vegetable Carbon</td>
</tr>
<tr>
<td>Whites</td>
<td>Caramel</td>
</tr>
</tbody>
</table>

## Delivery Methods

- Water Soluble or Water Dispersible Colors
- Oxidative Stability
- Liquid Colors (not oil based)

## Natural Color Selection

<table>
<thead>
<tr>
<th>Colors</th>
<th>Natural Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reds</td>
<td>Carmine, Iron Oxide, Anthocyanins</td>
</tr>
<tr>
<td>Oranges</td>
<td>β-Carotene, Paprika, Canthaxanthin</td>
</tr>
<tr>
<td>Yellows</td>
<td>Turmeric, Riboflavin, β-Carotene</td>
</tr>
<tr>
<td>Greens</td>
<td>Mixture of Blues &amp; Yellows</td>
</tr>
</tbody>
</table>

## Natural Color Selection

<table>
<thead>
<tr>
<th>Colors</th>
<th>Natural Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blues</td>
<td>Anthocyanins</td>
</tr>
<tr>
<td></td>
<td>Spirulina</td>
</tr>
<tr>
<td>Violets</td>
<td>Anthocyanins, Mixtures of Blues and Reds</td>
</tr>
<tr>
<td>Blacks</td>
<td>Vegetable Carbon, Iron Oxide, Caramel</td>
</tr>
<tr>
<td>Whites</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Marshmallow

**Common Concerns/Issues**

- Flavor Off Notes
- Light and oxidative stability
- Heat stability
- De-aeration due to the surfactant nature of some carriers, oil soluble colors
- Inability to get dark color
- Base color influence

**Possible Controls/Solutions**

- Control density to assure consistent color
- Add heat sensitive colors toward end of process
- Use opaque packaging for light sensitive colors and protection for WIP
- Choose pastel colors

Sugar/ corn syrup

Sugar/ Dried Cane/ tapioca syrup

Dried Cane/ brown rice syrup
PMCA Webinar

May 31, 2016
Regulation of “natural” colors

- Color additives exempt from certification – “natural colors”
  - Some are readily recognizable as foods or derived from natural food sources such as vegetables
    - Ex. paprika, turmeric, tomato lycopene, grape skin extract, fruit and vegetable juices
  - Some have animal sources
    - Ex. cochineal/carmine
  - Others are mineral in origin
    - Ex. titanium dioxide
  - Or synthesized/processed
    - Ex. caramel, canthaxanthin

- Specifications and requirements in 21 CFR Part 73
US FDA Labeling of Foods Containing Colors

- No provision in the FDA regulations for the designation of color additives as “natural”
  - Color additives are “certified colors” or “color additives exempt from certification”

- Exempt from Certification Colors must be declared
  - Either as “artificial color,” “artificial color added,” or “color added”
  - Or, as “colored with _____” or “______” color”

- Are there any circumstances in which a food may be labeled as “naturally colored” or “colored naturally” or something similar?
  - Yes, if the color additive was from the food it is coloring
US FDA Labeling of Foods Containing Colors

- Carmine/cochineal
  - Specific declaration required – 21 CFR 73.100(d)(2)
  - Allergenic in small proportion of the population
- Paprika, turmeric, saffron, other spices that may be used as colors—“spice and coloring.” 21 CFR 101.22(b)(2)
- Fruit juice (21 CFR 73.250) and vegetable juice (21 CFR 73.260)
  - Attractive for clean label purposes.
  - Key issue is that these must be juices, not pigments isolated from juices.
  - FDA has issued regulatory correspondence on this topic collected by IACM for member use
In Europe, all food additives are given labeling codes commonly referred to as “E-numbers”

- Colors are traditionally labeled not by name but by E-number

Colors are considered Food Additives

- Substances which add or restore color in a food, and include natural constituents of foods and natural sources which are normally not consumed as foods as such and not normally used as characteristic ingredients of food.
- Preparations obtained from foods and other edible natural source materials obtained by physical and/or chemical extraction resulting in a selective extraction of the pigments relative to the nutritive or aromatic constituents are colors within the meaning of this Regulation
  - Selective Extraction is not defined in EU legislation but Commission developed Guidance notes on the classification of food extracts with coloring properties

Colors are not:

- foods, whether dried or in concentrated form, including flavorings incorporated during the manufacturing of compound foods, because of their aromatic, sapid (taste) or nutritive properties together with a secondary coloring effect
EU Coloring Foods

DEcision Tree
(to be used together with the Guidance notes and the checklist in Annex II)
How to Distinguish between a Colouring Food and an Additive Food Colour

Primary extract with colouring properties

YES
FOOD or FLAVOURING

Q1. Is the primary extract a food incorporated during the manufacturing of compound foods, because of its acoustic, aird or nutritive properties together with a secondary colouring effect?
See also section 3

NO

Q2. Is the source material a food or a characteristic ingredient of food which is normally consumed as such within the EU?
See also section 4

YES

Q3. Does the source material undergo selective physical and/or chemical extraction?
(Refer to selective extraction criteria section)

NO

Q4. Is the primary extract permitted under Regulation (EC) No 1333/2008 and fully compliant with Commission Regulation (EC) No 231/2012?

YES
COLOURING FOOD (in certain cases, a novel food authorisation may have been granted)

NO
COLOUR Approved in the EU

NO
COLOUR Not approved in the EU
Canadian Regulations

• Colors are regulated by the Canadian Food and Drug Act, Division 6
  – B.06.01 Natural Colors (contains specifications and listed by pigment)
  – Table III (Division 16) Food Additives that may be used as coloring agents

• Basic Labeling Requirements are included in Annex 2-2 Class Names for Ingredients [B.01.010(3)(b)]
  – When one or more of the colors listed in Table 3 of Division 16 are used label as “Color”
  – Labels must be bilingual (English and French)

• Canada has proposed amendments that would require that manufacturers list all food colors by their common name within the list of ingredients on the food label
Codex GSFA

- There are currently 46 colors with draft and/or adopted provisions in the GSFA
  - 8 colors have a JECFA ADI of “not specified” and are listed in Table 3 of the GSFA
    - Examples include Beet red, 3 Lycopenes and Titanium dioxide
  - 38 colors have a numerical ADI and are only listed in Tables 1 and 2 of the GSFA
- Total of 1,895 draft and adopted provisions for colors in the GSFA
  - Represent ~ 1/3 of all provisions in the GSFA
  - 990 adopted provisions and 905 draft provisions
- New additives must be assigned an INS number by CCFA and undergo a JECFA review before being considered for GSFA
  - IACM has requested new INS numbers for: spirulina extract, red radish color, purple sweet potato color, carthamus yellow, black carrot extract and JECFA review of spirulina extract
- Note 161 Challenges
  - “Subject to national legislation of the importing country aimed, in particular, at consistency with Section 3.2 of the Preamble”
  - There are 125 provisions for colors in the GSFA associated with Note 161 (~30% of all provisions associated with Note 161)
International Regulations

• Most countries treat colors as a food additive and do not regulate “natural” colors differently than synthetic
  – Trend toward following Codex and/or EU model for regulating food colors
  – Issue with following Codex model (GSFA) is lack of colors and/or provisions that have been finalized due to ongoing issue of Note 161
Contact

Sarah Codrea
Executive Director

info@iacmcolor.org
202.293.5800
Thank you for joining the PMCA colors webinar

PRESENTERS:

Michael Jelavich, *Sensient Colors*
michael.jelavich@sensient.com

Pam Gesford, *The Hershey Company*
pgesford@hersheys.com

Sarah Codrea, *IACM (International Association of Color Manufacturers)*
scodrea@vertosolutions.net

pmca.com
www.iacmcolor.org