

Carotenoids for Colors: Beverages and beyond (EMEA)

June 21, 2022

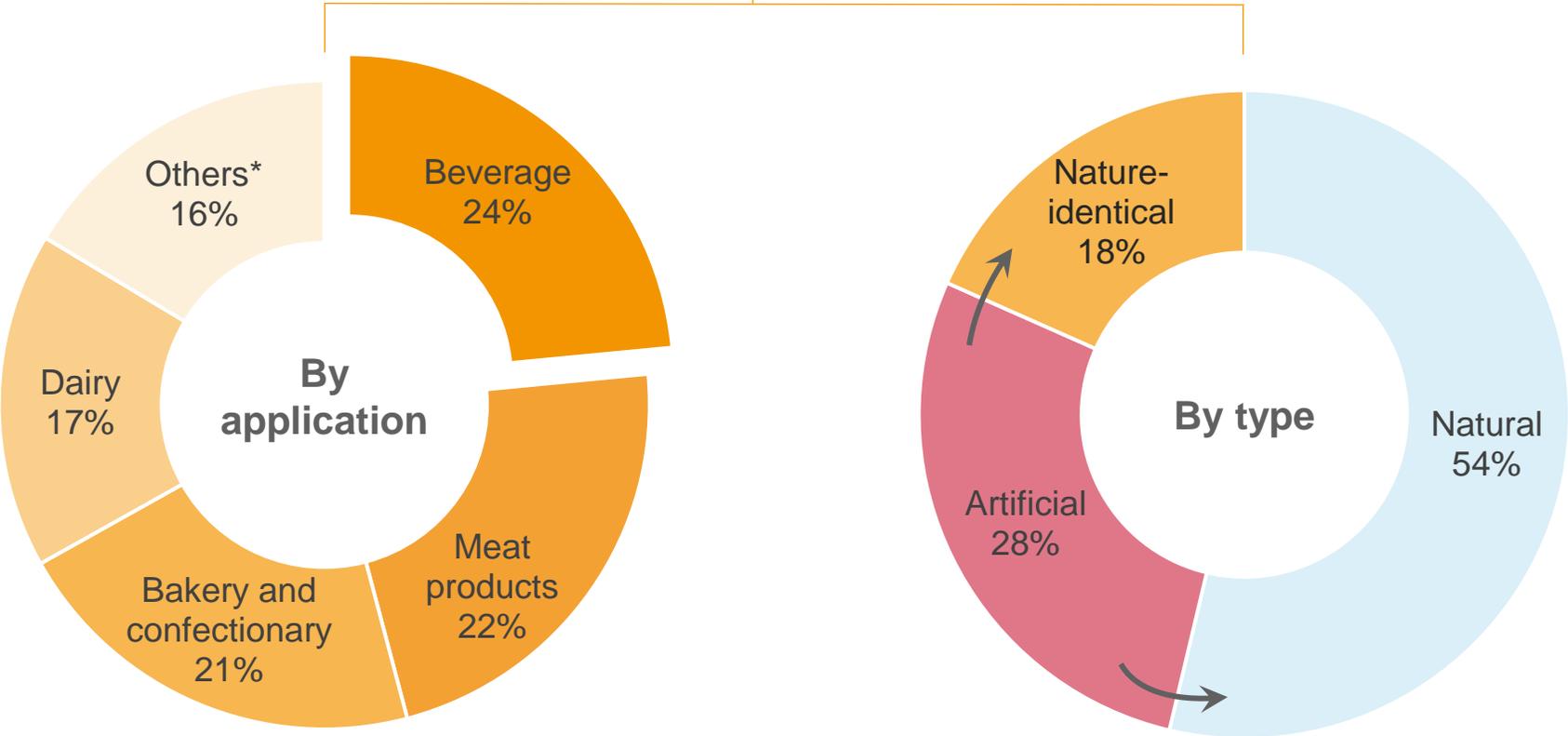


Agenda

- 1. Market insights and opportunitites**
2. BASF's portfolio overview
3. Application examples: beverages, dairy and oils & fats
4. Partnering for your innovations

Colors are most widely used in beverages; global market sees a switch away from artificial colors

The global food color market is estimated to be €3.2 billion in 2022



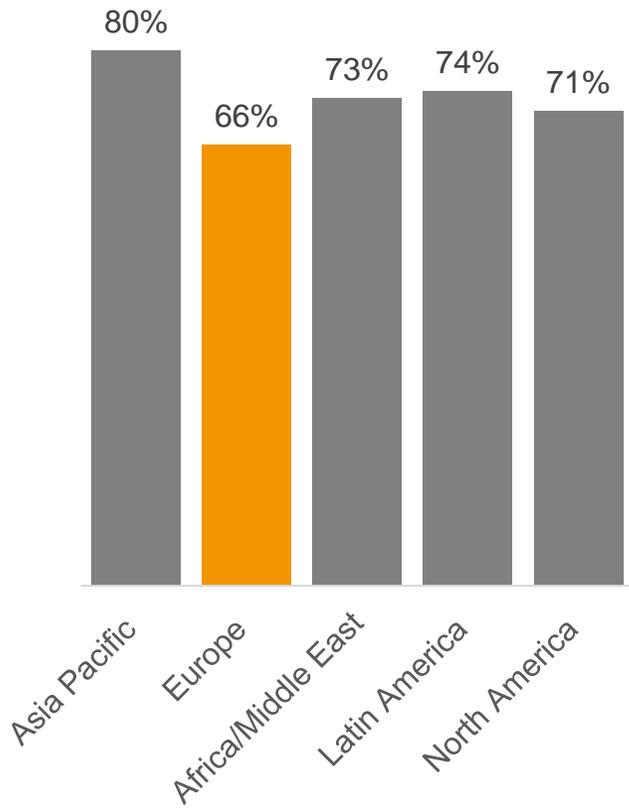
The use of carotenoids as food colors is forecasted to outperform the global market with growth of

6%

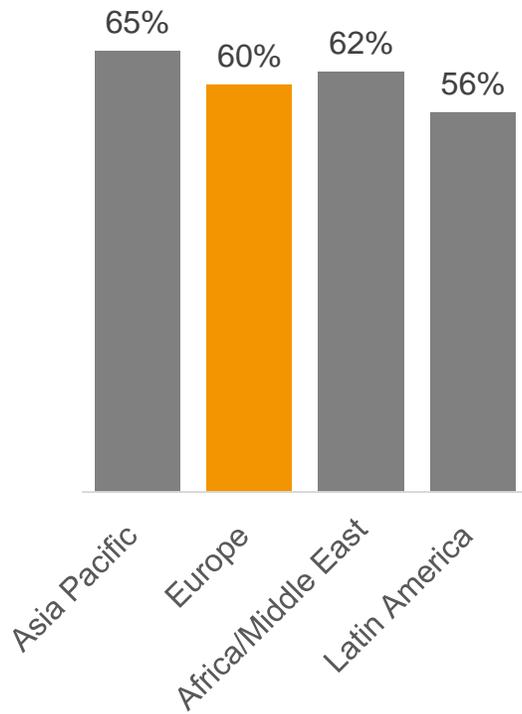
*Others include condiments, dressings and sauces, savory and snacks, frozen products etc

Consumers are concerned about the long-term health impact of artificial ingredients

I am concerned about the long-term health impact of artificial ingredients



I try to avoid foods that contain artificial colors



Volume sales of products claiming “without artificial colors or flavors”

↑ 5.4%

year over year from retail data in Germany and the United States



Perceived health concerns will continue to drive regulatory change globally, with more warning labels on artificial colors

2007

Implementation of warning labels related to the Southampton Six[^] colors

Present

A possible link was identified between hyperactivity in children and the consumption of six artificial colors, sparking consumer concerns about artificial colors

Europe

- May have an adverse effect on activity and attention in children

Russia

- Contains a coloring agent which may negatively affect children's activity and ability to concentrate

Middle Eastern countries*

- May have a negative impact on activity and concentration in children

Current initiative in California to mandate a warning label on foods that contain certain colors: "Synthetic dyes may cause or worsen behavioral problems in children"

[^]Tartrazine (E102), Quinoline yellow (E104), Sunset yellow FCF (E110), Azorubine, Carmoisine (E122), Ponceau 4R, Cochineal red A (E124), Allura red AC (E129)
^{*}Gulf Cooperation Council (GCC): Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, the United Arab Emirates



BASF offers nature-identical and natural carotenoid colors that do not require warning labels associated with artificial colors

Artificial

- Tartrazine
- Quinoline yellow
- Sunset yellow FCF
- Azorubine, Carmoisine
- Ponceau 4R, Cochineal red A
- Allura red AC
- *Etc*

Warning label may be required in some countries; for example:
“May have an adverse effect on activity and attention in children”

Nature-identical

- **Beta-carotene**
- **Lycopene**
- **Apocarotenal**

Natural

- **Beta-carotene** from fermentation using fungus *Blakeslea trispora*
- **Beta-carotene** from micro-algae *Dunaliella salina*
- **Lutein esters** from *Tagetes erecta* (Marigold flowers)
- **Riboflavin** from fermentation using fungus *Ashbya gossypii*

No warning label required.
Voluntary marketing claims outside the United States*:
✓ Non-artificial color
✓ Does not contain artificial color

*NATCOL: Natural Food Colours Association: Position on the Term ‘Natural Colour’ and the Categorisation of Food Colours

Claims regarding "natural" colors and the lack of "artificial colors" are prohibited under U.S. FDA regulations. Under these regulations, any coloring added to a product, even those derived from natural sources, are considered "artificial colors".

Use of carotenoid colors according to customers' choice

Nature-Identical



Nature-identical

- Carotenoids are synthesized with molecular structures identical to those found in nature
- More economical, **suitable for mass market food and beverages switching away from artificial colors**



From fermentation using *Blakeslea trispora*

- Beta-carotene is obtained by fermentation process using natural strains of *Blakeslea trispora* fungus
- Natural claims possible outside the United States*, **suitable for upgrade from nature-identical to natural colors**



Extracted from *Dunaliella salina*

- Dunaliella salina* thrives naturally in seawater lagoons located in Australia
- Beta-carotene obtained from *Dunaliella salina* is the most natural and sustainable for environment
- Natural and plant-based claims possible outside the United States*, **suitable for the growing segment of plant-based foods**

Natural



The seawater lagoons take on their famous vivid pink color from the presence of *Dunaliella salina* swimming freely in the hypersaline water

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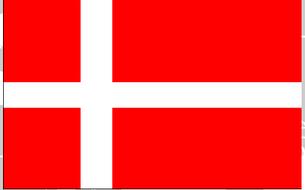
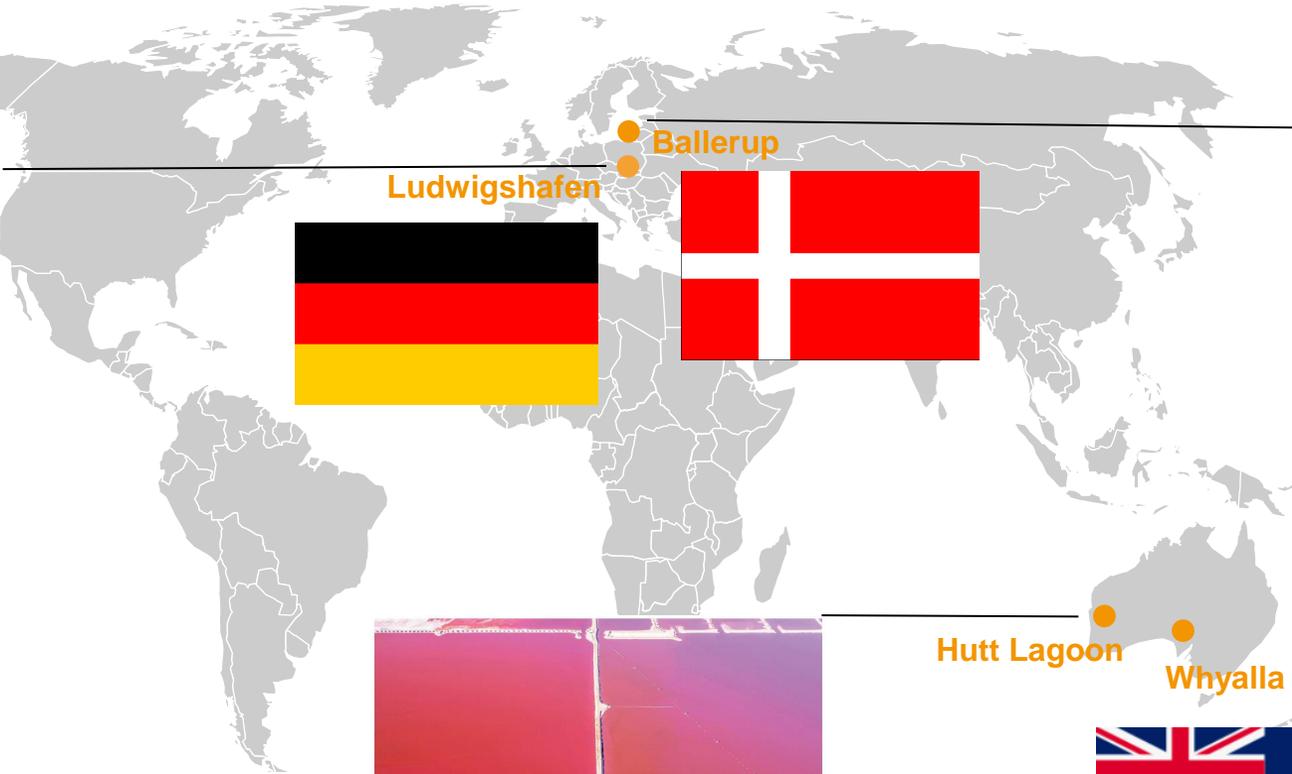
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Production sites in Germany, Denmark and Australia produce according to highest standards and quality of carotenoid products



- Apocarotenal
- Beta-carotene
- Lycopene



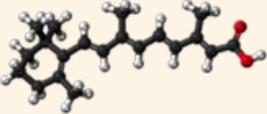
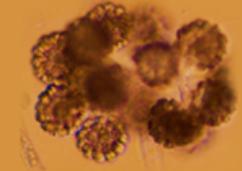
- Beta-carotene



- Beta-carotene
- Lycopene



BASF provides a comprehensive product range of carotenoid colors including oil dispersions and cold-water dispersible powders

	Nature-identical	Natural		
	Synthesis	Fungus	Algae	Flowers
Types	 <p>Synthesized, with molecular structures identical to those found in nature.</p>	 <p>Fermentation using <i>Blakeslea Trispora</i> to produce fermented beta-carotene</p>	 <p>Extraction from <i>Dunaliella Salina</i> to produce natural beta-carotene from algae</p>	 <p>Extraction from <i>Tagetes erecta</i> (Marigold flowers) to produce lutein esters</p>
Dispersions	<ul style="list-style-type: none"> ■ Beta-carotene 30% ■ Apocarotenal 20% ■ Lycopene 10% 	<ul style="list-style-type: none"> ■ Beta-carotene 30% 	<ul style="list-style-type: none"> ■ Beta-carotene 30% 	<ul style="list-style-type: none"> ■ Lutein ester 15%, 30%
Cold-water dispersible powders	<ul style="list-style-type: none"> ■ Beta-carotene 1%, 10% and 20% ■ Lycopene 10% 	<ul style="list-style-type: none"> ■ Beta-carotene 1%, 10% 	<ul style="list-style-type: none"> ■ Beta-carotene 1% 	<ul style="list-style-type: none"> ■ Lutein ester 10%
Labelling*	<ul style="list-style-type: none"> ■ Non-artificial color ■ Does not contain artificial colors 		<ul style="list-style-type: none"> ■ With added natural color ■ Natural-origin color ■ Natural color 	

*Voluntary marketing claims allowed in EU. These claims are not allowed in U.S. Please refer to regional regulatory for country-specific requirements.

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Our products are developed to perform optimally in key applications where beta-carotene is commonly used as color



Beverages



Dairy Products



Oils & Fats



Baked goods



Beverages

Colors are usually added to beverages to reflect the variety of flavors and/or to maintain color consistency of the final product.

Color attracts the consumers

BFG Exotic Beverage



Bulgaria
<https://bbfcompany.com/products/vrg-exotic/>

IZZE Pepsico Sparkling Beverages



US
<https://contact.pepsico.com/izze/about-us>

HeyTea Tea-based Beverages

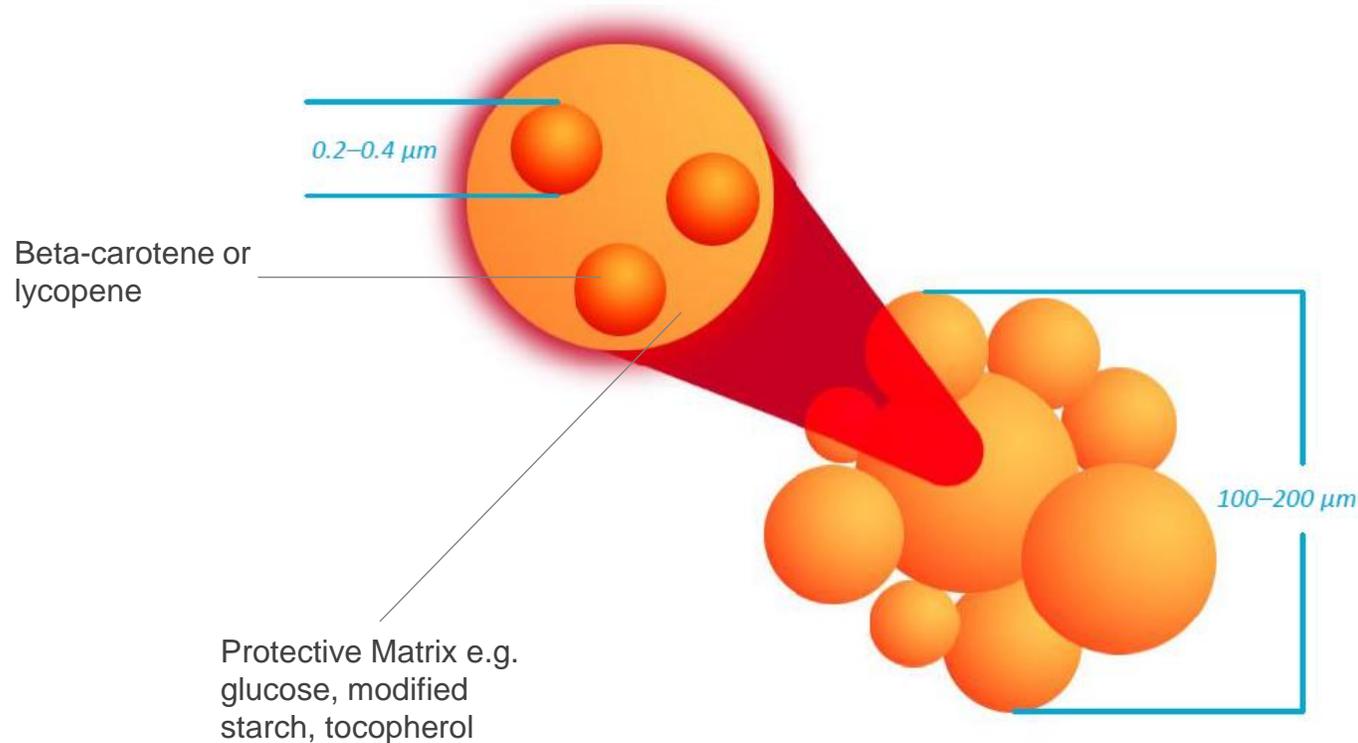


China
<https://downloads.mintel.com/private/dMxvk/files/887138/>

Third-party product names and images are used for reference only and are not intended to suggest endorsement by, or an existing licensing relationship with, the trademark owner.

BASF does not approve or endorse any health claim made by any of the products pictured and is not liable for the use of any such claim.

BASF's formulation expertise enables production of cold-water dispersible powders with favorable technical properties



- Easily dispersible in beverages
- Stable and consistent across a broad pH range
- Do not produce off-odors or tastes
- Provide good light and heat stability
- Ideal choice for use in food and beverages fortified with vitamin C

Our products are suitable for clear beverages such as soft drinks, flavored waters as well as sports and energy drinks

Lucarotin® 1 CWD/Y or Lucarotin® B 1 CWD/Y



2ppm

4ppm

8ppm

Beta-carotene content

LycoVit® 10 CWD/S



8ppm

4ppm

2ppm

Lycopene content

Recommended flavors:



Lemon



Pineapple



White peach



Cherry

See it with your own eyes - excellent water dispersibility of Lucarotin[®] 1 CWD/Y



0 seconds



5 seconds



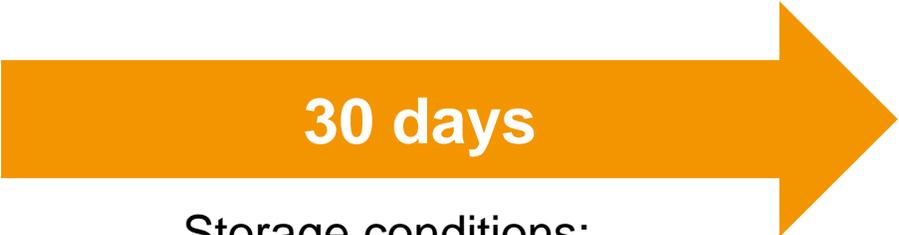
10 seconds



Our 30-day stability test in sports beverages shows our products do not result in ringing under stress conditions



Sports beverages produced according to standard operating procedures



Storage conditions:
Room temperature, indoor daylight



No ringing detected

Products tested: 5 ppm carotene with Lucarotin® 1 CWD/Y, Lucarotin® B1 CWD/Y, LycoVit 10 CWD/S

Our products are suitable for cloudy beverages such as carbonated beverages and fruit juices

Lucarotin® 1 CWD/Y or
Lucarotin® B 1 CWD/Y

Lucarotin® 10 CWD/O Plus or
Lucarotin® B 10 CWD/O Plus

Beta-Carotene 20% CWD/R



10 ppm* 15 ppm 2 ppm 4 ppm 8 ppm 10 ppm 4 ppm 8 ppm 10 ppm 15 ppm

Beta-carotene content

Recommended flavors:



Mango



Orange



Pink grapefruit

* More turbidity can be achieved by adding cloudifier

See it with your own eyes - excellent water dispersibility of Lucarotin[®] 10 CWD/O Plus with gentle stirring



0 seconds



10 seconds



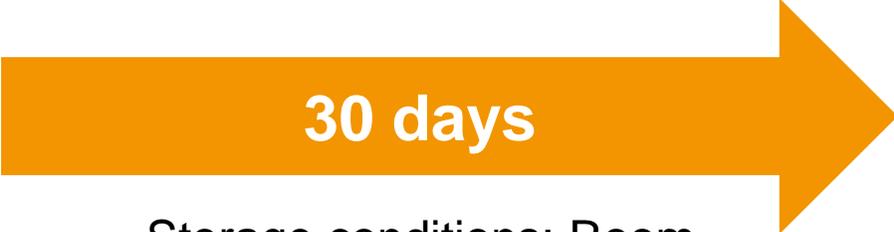
15 seconds



Our 30-day stability test in orange juices shows our products result only in very slight ringing under stress conditions



Orange juices produced according to standard operating procedures



Storage conditions: Room temperature, indoor daylight



Very slight ringing detected

Products tested: Lucarotin® 10 CWD/O PLUS, Lucarotin® B10 CWD/O PLUS, Beta-carotene 20% CWD/R

Our 30-day stability test in sports beverages shows our products do not result in ringing under stress conditions



Sports beverages produced according to standard operating procedures



Storage conditions:
Room temperature, indoor daylight

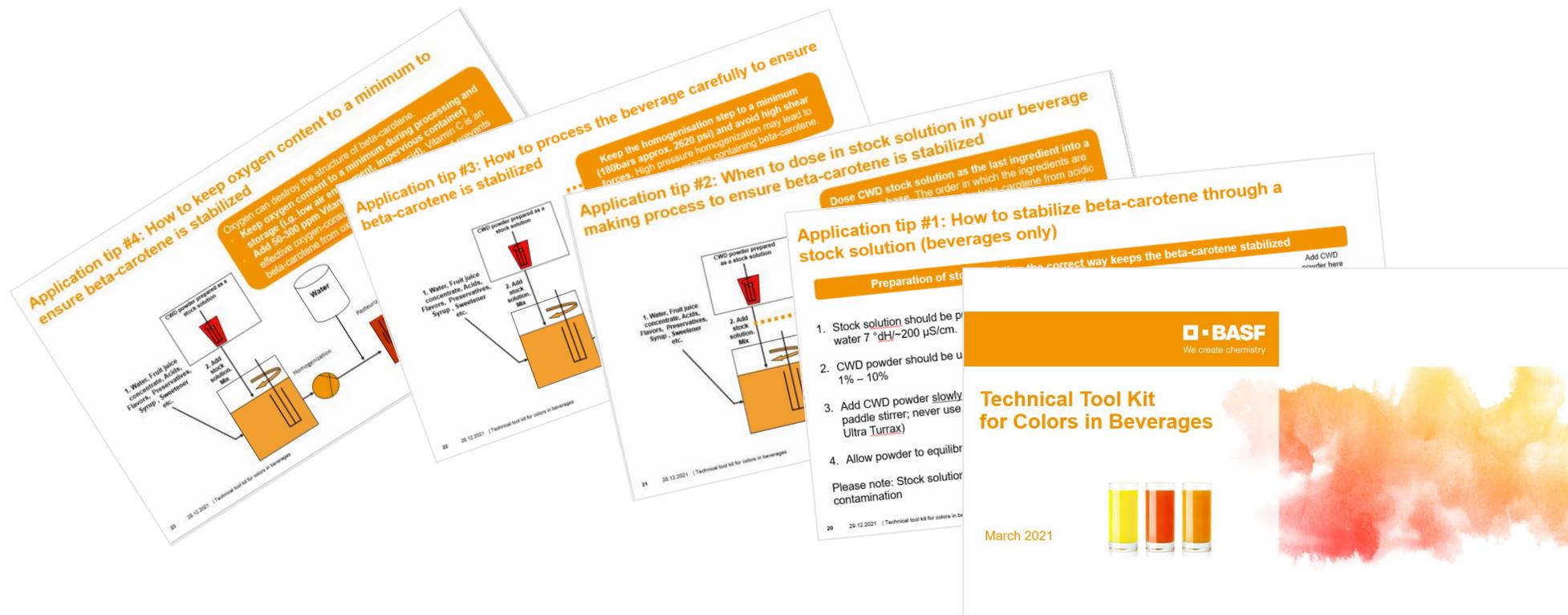


No ringing detected

Products tested: 5 ppm carotene with Lucarotin® 10 CWD/O PLUS, Lucarotin® B10 CWD/O PLUS

Our long experience with carotenoids in beverages support customers with troubleshooting matters

- Technical toolkit available for application tips using our products in beverages when dealing with color change, ring formation, sedimentation, cap / bottle staining





Dairy

Colors are usually added to dairy products like milk, yogurt and cheese to reflect the variety of flavors and/or to maintain color consistency of the final product.

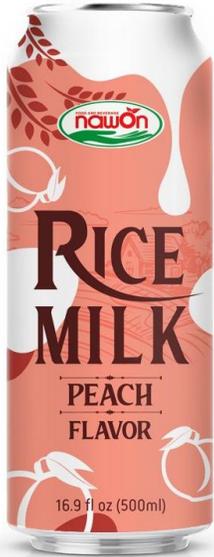
Color attracts the consumers

Danone Activia Yogurt (with carotene)



Canada
<https://www.walmart.ca/en/ip/activia-yogurt-with-probiotics-lemon-flavour-650g/6000195508555>

Nawon Rice Beverage (with carotene)



Vietnam
<https://nawon.com.vn/product/horchata-milk-rice-milk-drink-cinnamon-flavor-500ml/>

Hochland Cheddar Cheese Slices (with carotene)



Germany
<https://www.hochland.de/produkt/hochland-sandwich-scheiben-mit-cheddar/>

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Play around with our products to achieve the desired color for your flavored milk

 Plant-based option



Beta-carotene 20% CWD/R
10 ppm

LycoVit 10 CWD/S
5 ppm

Lucarotin® 10 CWD/O PLUS
20 ppm

Lucarotin® 1 CWD/Y
1 ppm

Lucarotin® B1 CWD/Y
5 ppm

Betatene 1% CWD N
10 ppm

All ppm values expressed as active beta-carotene / lycopene content
Colors have been applied digitally based on lab trial results, to reflect actual colors as much as possible

Mixing of products is also possible to achieve the desired shades in your yogurt applications



Lucarotin® 1 CWD/Y
0.5 ppm

Lucarotin® 1 CWD/Y
1.5 ppm

Betatene 1% CWD N
3 ppm

Lucarotin® 10
CWD/O Plus
3 ppm

Lucarotin® 1 CWD/Y +
Beta-Carotene 20%
CWD/R
0.5 ppm + 3 ppm

Lucarotin® 1 CWD/Y +
Beta-Carotene 20%
CWD/R
3.5 ppm

 Plant-based option

Recommended flavors:



Peach



Mango



Strawberry

All ppm values expressed as active beta-carotene / lycopene content
Colors have been applied digitally based on lab trial results, to reflect actual colors as much as possible

Colors suitable for processed cheese

Lucarotin® 30 SUN



6 ppm

Lucarotin® 1 CWD/Y



0.2 ppm 1 ppm 2 ppm 3 ppm 5 ppm

All ppm values expressed as active beta-carotene content



Fats & Oils

Colors are commonly added to products such as margarines to mimic the appearance of butter. They may additionally be used in products such as dressings and oils.

Color attracts the consumers

**Becel 'Original' Margarine
(with carotene)**



Canada
<https://www.becel.ca/en-ca/products/spreads/becel-original>

**Kerrygold Margarine Spread
(with carotene)**



Germany
<https://www.kerrygold.de/produkte/>

**Best Foods Mayonnaise
(with beta-carotene)**



United States
<https://www.bestfoods.com/us/en/products/mayonnaise/canola-cholesterol-free-mayonnaise-dressing.html>

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Colors suitable for oils, spreads and further applications

Lucarotin® 30M



0 ppm 1 ppm 4 ppm 8 ppm 16 ppm
Beta-carotene content [ppm]

Natural Beta-carotene 30% MCT



Oil 1 ppm 4 ppm 8 ppm 16 ppm
Beta-carotene content [ppm]

Lucarotin® 30 SUN



18 ppm

All ppm values expressed as active beta-carotene content
Colors have been applied digitally based on lab trial results, to reflect actual colors as much as possible

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Our application labs situated around key markets are ever ready to provide color matching services and additional technical support



- ▶ Health Ingredient
- ▶ Food Performance Ingredient

Our application labs are well-equipped to perform color matching tests for you



**Turbidimeter
Hach-Lange
for turbidity
measurement**



**Photometer
Analytik Jena
for active content
and color intensity**



**Pantone light box
for comparable
lighting conditions
(D65)**



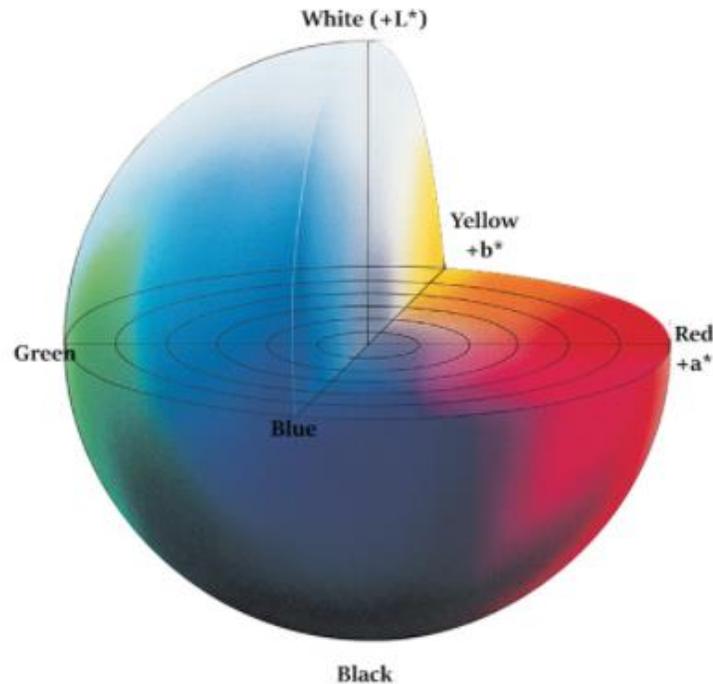
**Spectrophotometer
CM-5 Konica
Minolta for $L^*a^*b^*$
values and ΔE**

Identifying colour differences using CIE L*a*b* coordinates

L* : Indicates lightness

a* : +a* is the red axis, -a' is the green axis

b* : +b* is the yellow axis and -b* is the blue axis



Defining Delta E (ΔE)

- ΔE (dE) is to describe the differences between two colours
- The term delta means change in a variable or function while suffix E references the German word 'Empfindung' (perception)
- On a typical scale, the Delta E value will range from 0 to 100

Delta E	Perception
≤ 1.0	Not perceptible by human eyes.
1 - 2	Perceptible through close observation.
2 - 10	Perceptible at a glance.
11 - 49	Colors are more similar than opposite
100	Colors are exact opposite

We have successfully conducted many color matching trials with major beverage companies to replace artificial colors*

Pineapple-flavored drink



Lucarotin® 1 CWD/Y (BC content 1.25ppm) **Quinolin Yellow
Sunset Yellow**

Deep orange soft drink



Lucarotin® 10 CWD/O Plus (BC content 2.2ppm) & Beta-Carotene 20% CWD/R (BC content 7ppm) **Sunset yellow
Allura red**

Pink grapefruit juice drink



Beta-Carotene 20% CWD/R (BC content 0.7ppm) with cloud added **Allura red**

Strawberry-flavored drink



LycoVit 10 CWD/S (Lycopene content 13ppm) **Azorubine**

*Closest to sample compared to other alternatives

We have also performed color matching successfully for customers in other applications like margarine

Taken at room temperature (24°C)

BASF Prototype



Target Profile

- $\Delta E = 2.63$ after cooling in fridge (4°C)
- Marginal perceptible differences between our formulated margarine and target profile

We can collaborate with you on the use of our products in different applications/conditions

Color matching

- Conduct color matching and recommend the best product and dosage in your applications



Stability trials

- Conduct stability trials to determine performance of our products in your applications

We have excellent know-how in colors to support market needs



We are a trusted carotenoids supplier with decades of experience, headquartered in Germany



Our portfolio of natural and nature-identical colors is available in choices from yellow to red



We have robust formulation expertise to develop products with excellent properties and quality



Our application labs situated around key markets are ready to support with color matching services

Explore ColorMyProduct – BASF’s digital tool that provides you a sneak preview of our colors that can be used in your applications



Explore now at:
<https://colormyproduct.basf.com/>

Quality, regulatory & product development expertise digitally delivered via our Human Nutrition Virtual Assistants to empower you



 MyProductWorld Your ingredients & applications specialist Find suitable ingredients easily for your products & applications	 RegXcellence® Your regulatory & quality assistant Streamline your quality compliance process	 CLARA NEW Your real-time claims resource Access regulatory claims by market & find appropriate claims for ingredients
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We create chemistry