EXBERRY® Workshop
Basic

February 2025

EXBERRY®

We eat with our eyes

“Color clearly conveys to the brain what taste is to be expected”

Source: Stummerer S, Hablesreiter M. Food design XL. New York, NY: Springer; 2010.

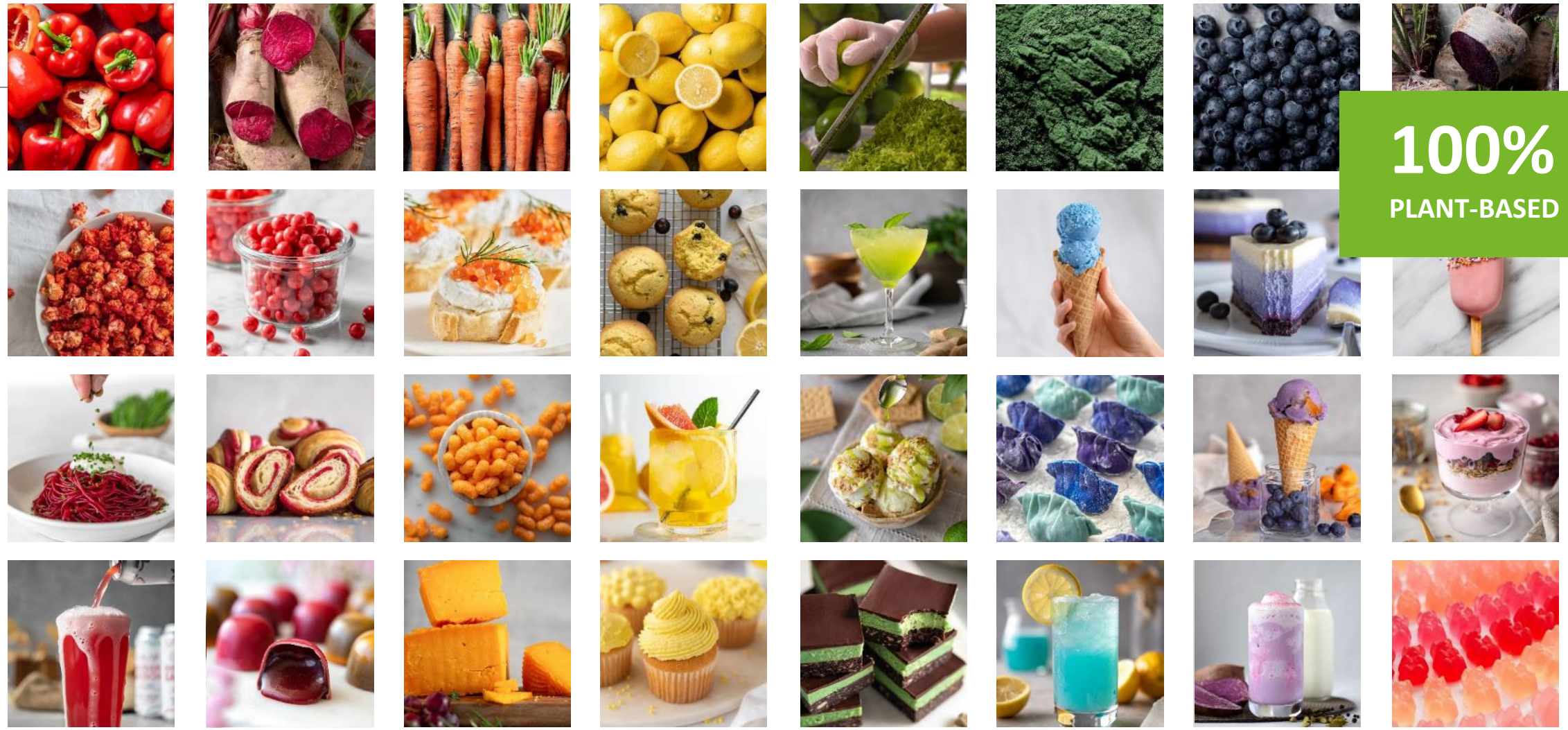
GROWING COLORS EXBERRY®

GROWING COLORS EXBERRY®

1

EXBERRY® Plant-based Colors

A full spectrum of vibrant shades to stand out on the shelf



100%
PLANT-BASED

EXBERRY® experience

Tasting of three different EXBERRY® products. Which raw materials do you taste?

1. EXBERRY® Shade Mandarin → Carrot + Apple
2. EXBERRY® Shade Vivid Red → Carrot + Blackcurrant
3. EXBERRY® Shade Blue - HP → Spirulina

Maximize consumer acceptance with trusted ingredients

Raw materials


Orange carrot


Safflower


Turmeric


Pumpkin


Spirulina


Blueberry


Dunaliella Salina


Black carrot


Radish


Paprika


Purple sweet potato


Beetroot


Hibiscus


Annatto seeds

Formats*


Standard liquid concentrate


Standard powder


Micronized powder


Oil-dispersible range


Oil-soluble range

Applications

*Format availability depends on raw material

What is important when using EXBERRY®?

3

Color shades of EXBERRY®

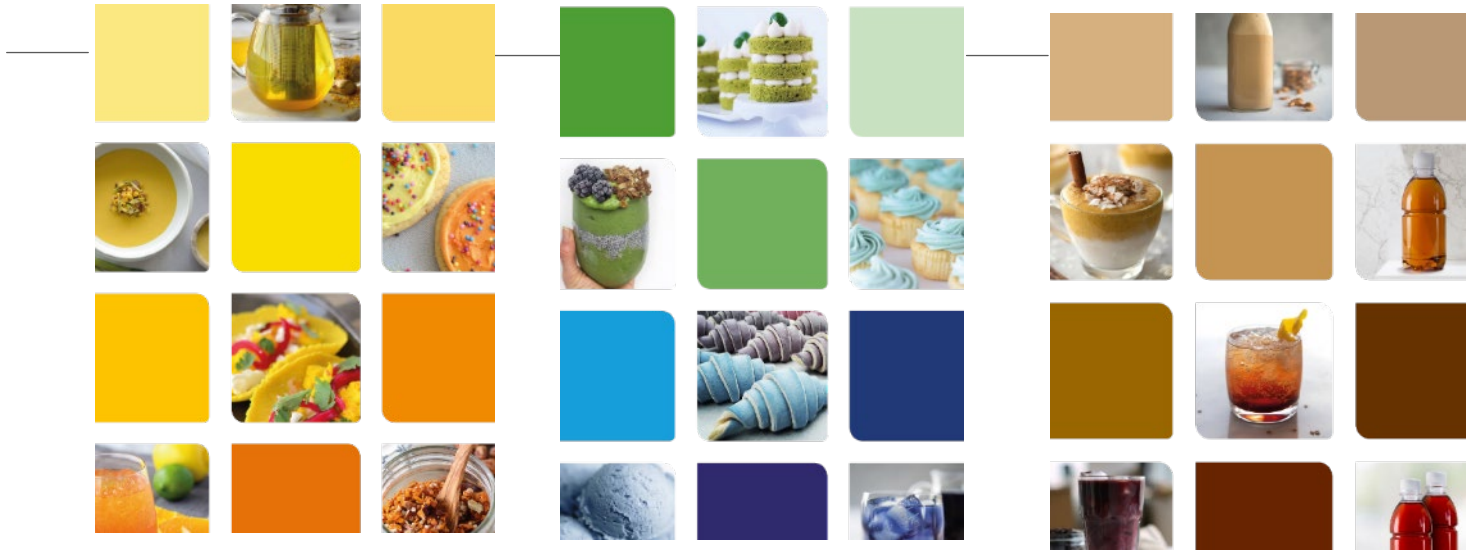
Red, Pink and Purple

Yellow and Orange

Blue and Green

Brown

Properties of RED,PINK & PURPLE EXBERRY® Products



Red, Pink and Purple plant-based solutions

Raw materials


Black carrot


Sweet potato


Radish


Elderberry


Chokeberry

Formats


Liquid concentrate


Powder


Micronized powder


Oil-dispersible

Applications


Bakery


Beverages


Savory


Confectionery


Cereals and snacks


Dairy


Plant-based


Ice cream

Red EXBERRY® products – Solubility in water

0.03%
Shade Veggie Red
(radish, carrot)

0.05%
Shade Rubescent Red
(sweet potato, carrot)

0.03%
Shade Vivid Red
(carrot, blackcurrant)

0.03%
Shade Brilliant Pink
(sweet potato, carrot)

0.13%
Shade Fiesta Pink
(beetroot, carrot)

0.03%
Shade Purple Plum
(carrot, blueberry)

- All red EXBERRY® products are completely water soluble.
- A variety from yellowish red to bluish red color hues.

EXBERRY®: Experiment

1. Add **10 drops** of EXBERRY® Shade Vivid Red into the beaker with tap water (2 L) and mix.

   Take a sample by pouring the colored water into one of the small beakers.

2. Add **1 drop** of citric acid solution (50 % w/w) to the beaker and mix.

   Take a sample.

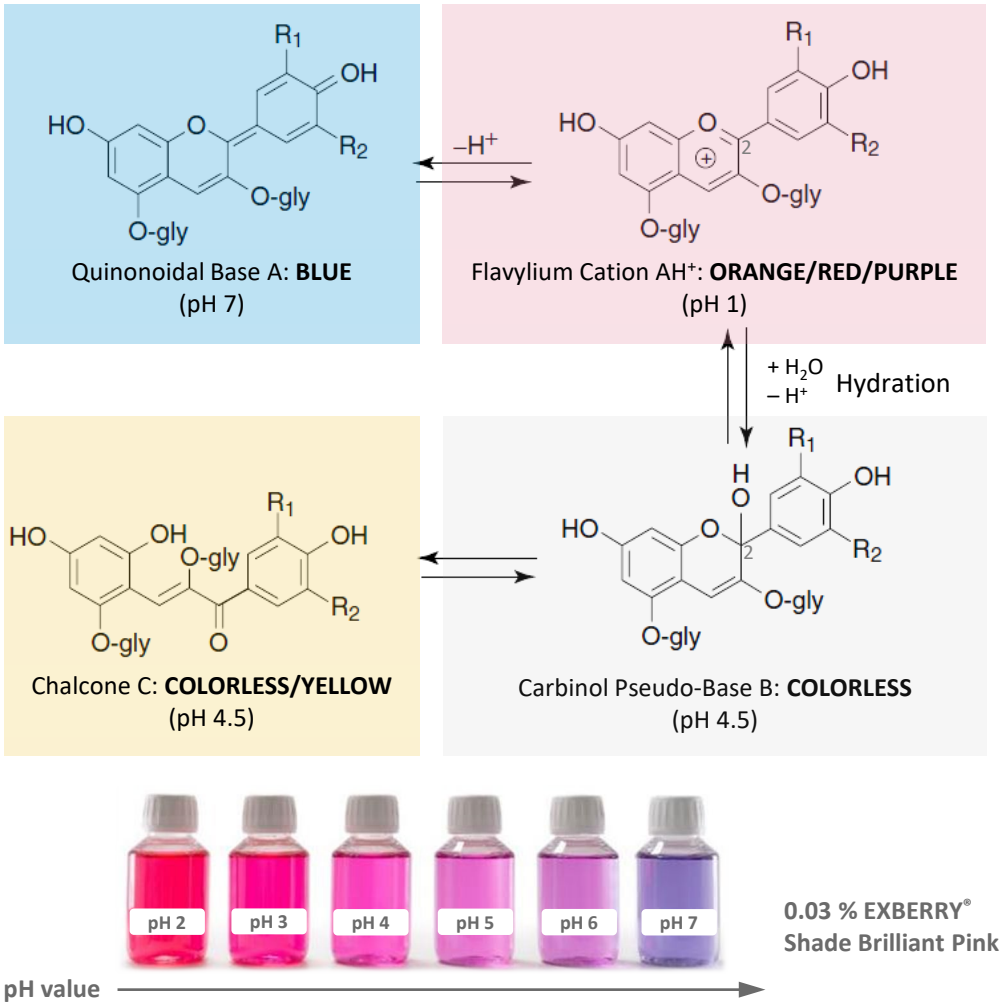
3. Add **a whole pipette** of citric acid solution to the beaker and mix.

   Take a sample.

➢ What do you see?

Influence of pH value: Red, pink and purple EXBERRY® (1)

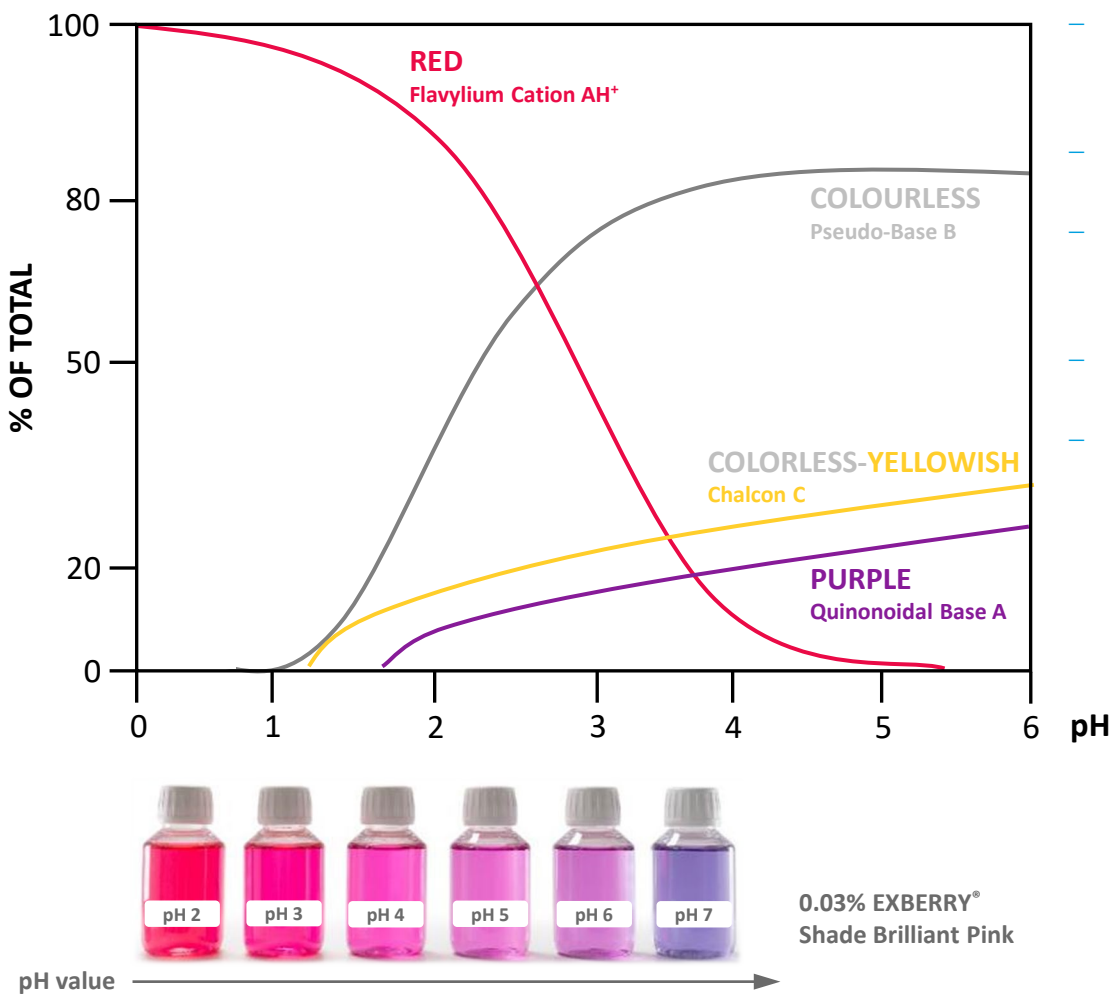
- Transformation of **anthocyanins** at different pH values



- The color shade of anthocyanins depends on the pH value of the application.
- 4 molecular anthocyanin configurations exist in equilibrium:
  - Flavylium cation AH+: **RED**
  - Quinonoidal Base A: **BLUE**
  - Carbinol Pseudo-Base B: COLORLESS
  - Chalcone C: COLORLESS-**YELLOW**
- All forms are present at the same time. The relative amount of each form at equilibrium varies with pH value and anthocyanin structure.
- At acidic pH value (< 2) the red flavylium cation is dominant.
- At increasing pH conditions (3-6), colorless carbinol pseudo-base and chalcone structures are formed.
- At neutral pH value (7) the blue quinonoidal base is dominant.
- At pH 4–6, an anthocyanin solution has very little hue due to the small amount of flavylium cation and quinonoidal base!

Influence of pH value: Red, pink and purple EXBERRY® (2)

- Transformation of **anthocyanins** at different pH values



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Influence of water composition

0.03% EXBERRY® Shade Vivid Red

pH 5.3 → **pH 4.1**

Demineralized Water (GNT Aachen)

pH 8.3 → **pH 6.7**

Tap Water (GNT Aachen)

pH 7.8 → **pH 6.9**

VOLVIC Mineral Water

Bicarbonate: 74 mg/L

pH 7.8 → **pH 7.3**

VIO Mineral Water

Bicarbonate: 152 mg/L

pH 7.7 → **pH 7.2**

VILSA Mineral Water

Bicarbonate: 175 mg/L

pH 7.5 → **pH 7.3**

VITTEL Mineral Water

Bicarbonate: 248 mg/L

pH 7.4 → **pH 7.3**

EVIAN Mineral Water

Bicarbonate: 360 mg/L

pH 7.1 → **pH 7.1**

GEROLSTEINER Mineral Water

Bicarbonate: 577 mg/L

Influence of water composition

0.03% EXBERRY® Shade Vivid Red

pH 4.1 → **pH 2.9**

Demineralized Water
(GNT Aachen)

pH 6.7 → **pH 3.0**

Tap Water
(GNT Aachen)

pH 6.9 → **pH 3.0**

VOLVIC Mineral Water

Bicarbonate: 74 mg/L

pH 7.3 → **pH 3.2**

VIO Mineral Water

Bicarbonate: 152 mg/L

pH 7.2 → **pH 3.4**

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pH 7.3 → **pH 3.8**

EVIAN Mineral Water

Bicarbonate: 360 mg/L

pH 7.1 → **pH 4.4**

GEROLSTEINER Mineral Water

Bicarbonate: 577 mg/L

Influence of pH value: Red, pink and purple EXBERRY® (3)

- Appearance of **red, pink and purple** EXBERRY® products at different pH values

0.05% EXBERRY® Shade Rubescent Red
(Sweet potato, carrot)

0.03% EXBERRY® Shade Vivid Red
(Carrot, blackcurrant)

0.03% EXBERRY® Shade Brilliant Pink
(Sweet potato, carrot)

0.03% EXBERRY® Shade Purple Plum
(Carrot, blueberry)

0.13% EXBERRY® Shade Fiesta Pink
(Beetroot, carrot)

EXBERRY® made from beetroot are not pH dependent.

EXBERRY® products made from red fruits and vegetables that contain anthocyanins are pH dependent.

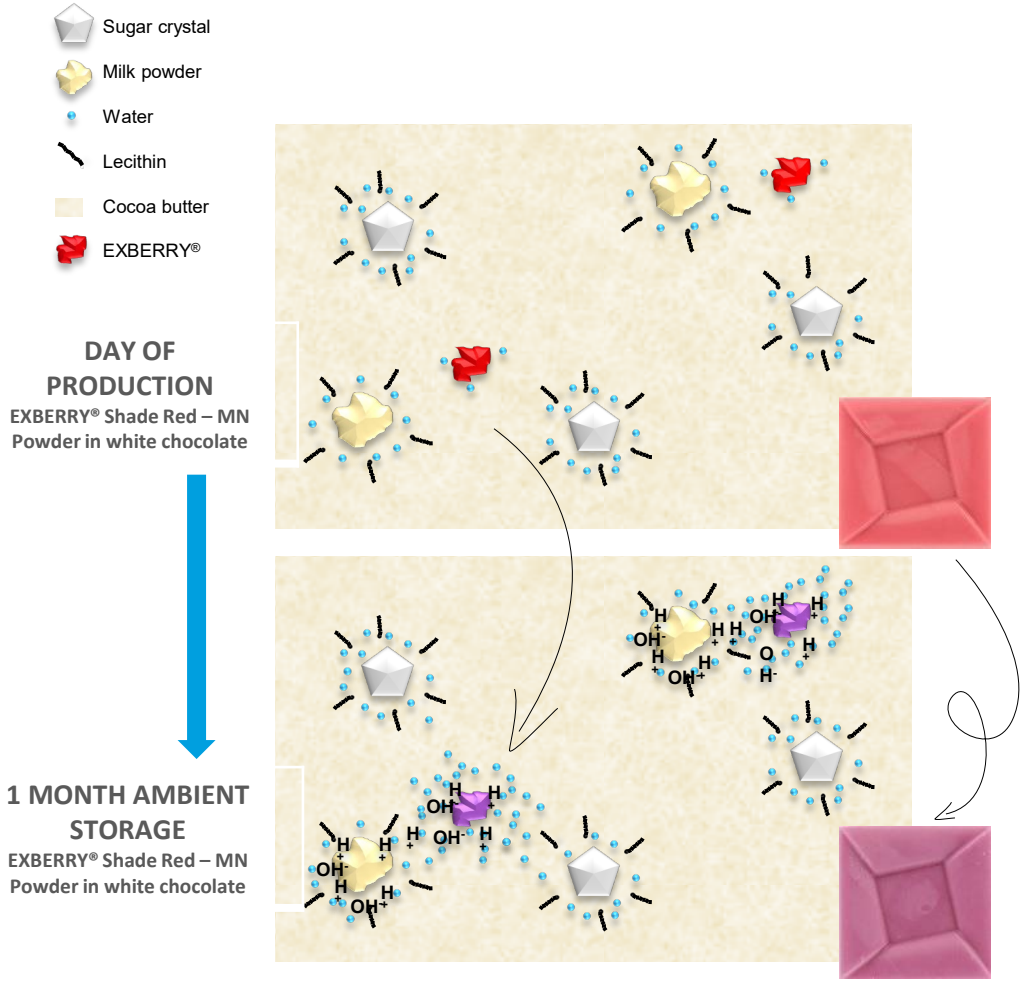
Anthocyanins in Chocolate – Color Shift

Chocolate colored with anthocyanin containing EXBERRY® products can shift from a red hue to a blue/purple hue

The color shift in chocolate/compound is most likely due to hydrophilic ingredients at the surface of the fat base (e.g., sugar, milk powder, soy lecithin) which are absorbing water from the surrounding environment

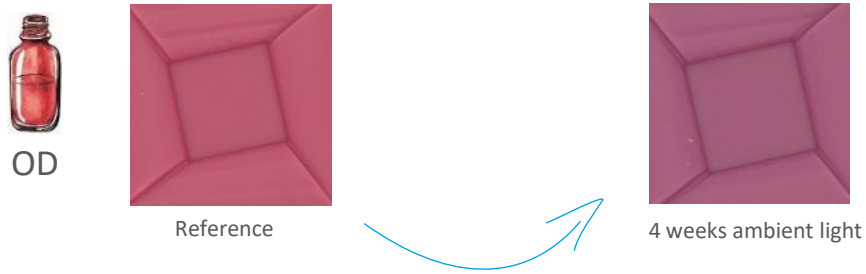
The high pH ingredients then partially hydrate with the anthocyanin pigments, which are water soluble, causing a color shift due to the high pH of their environment

The storage conditions of the product influence the rate of the color shift

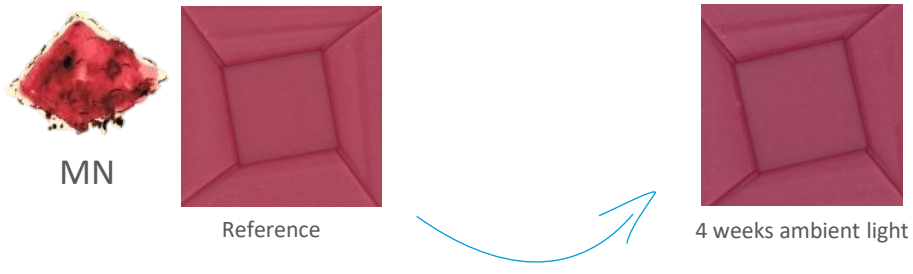


pH induced color shift with EXBERRY® MN – Powder and OD

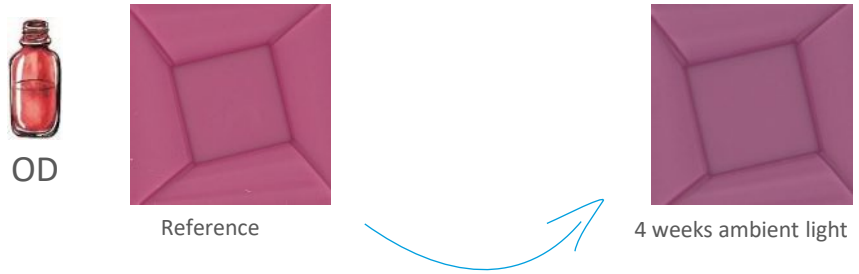
2.0% EXBERRY® Shade Red – OD



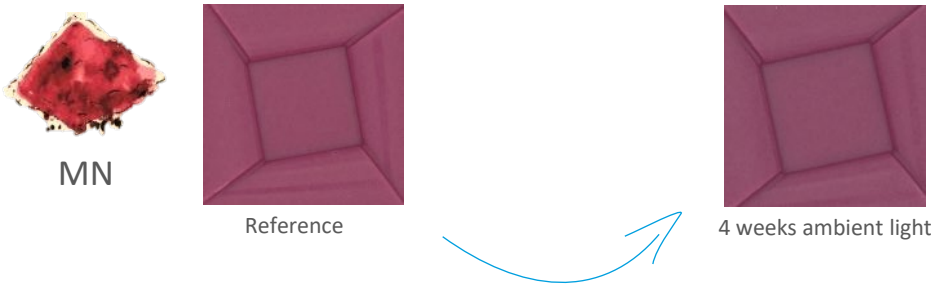
2.0% EXBERRY® Shade Red – MN Powder



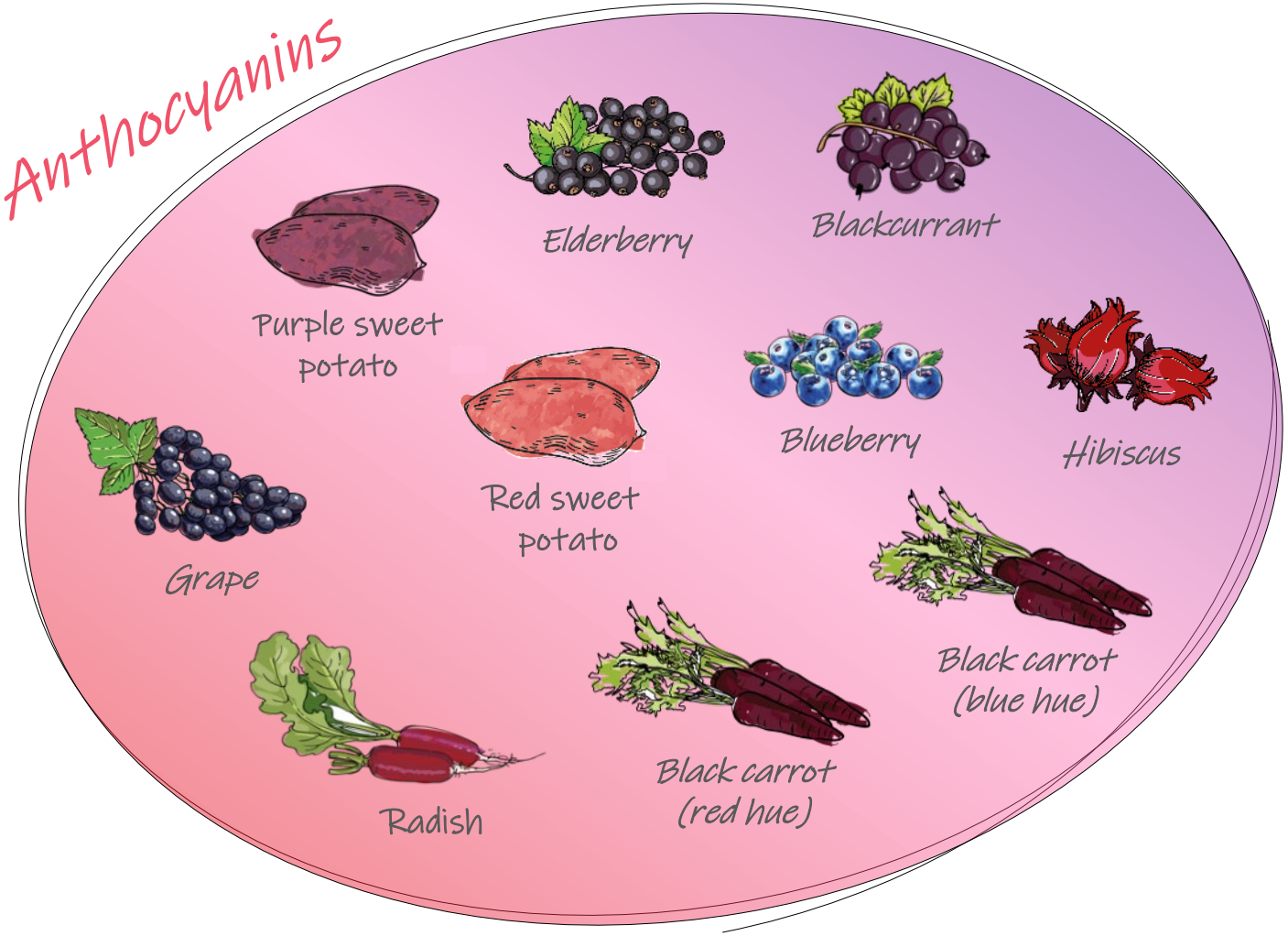
2.0% EXBERRY® Shade Pink – OD

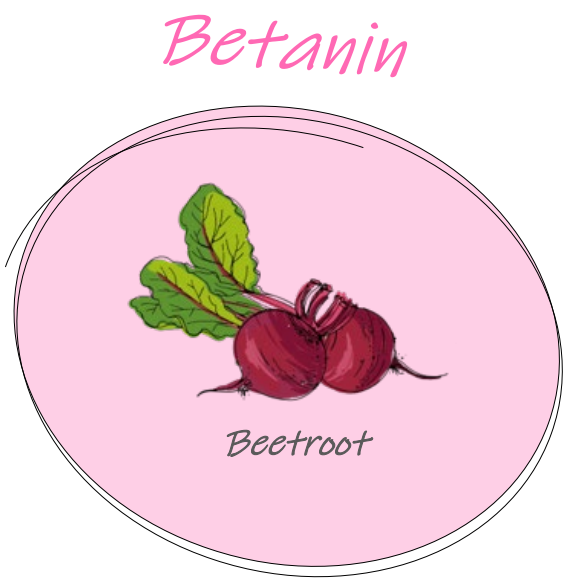


2.0% EXBERRY® Shade Pink – MN Powder

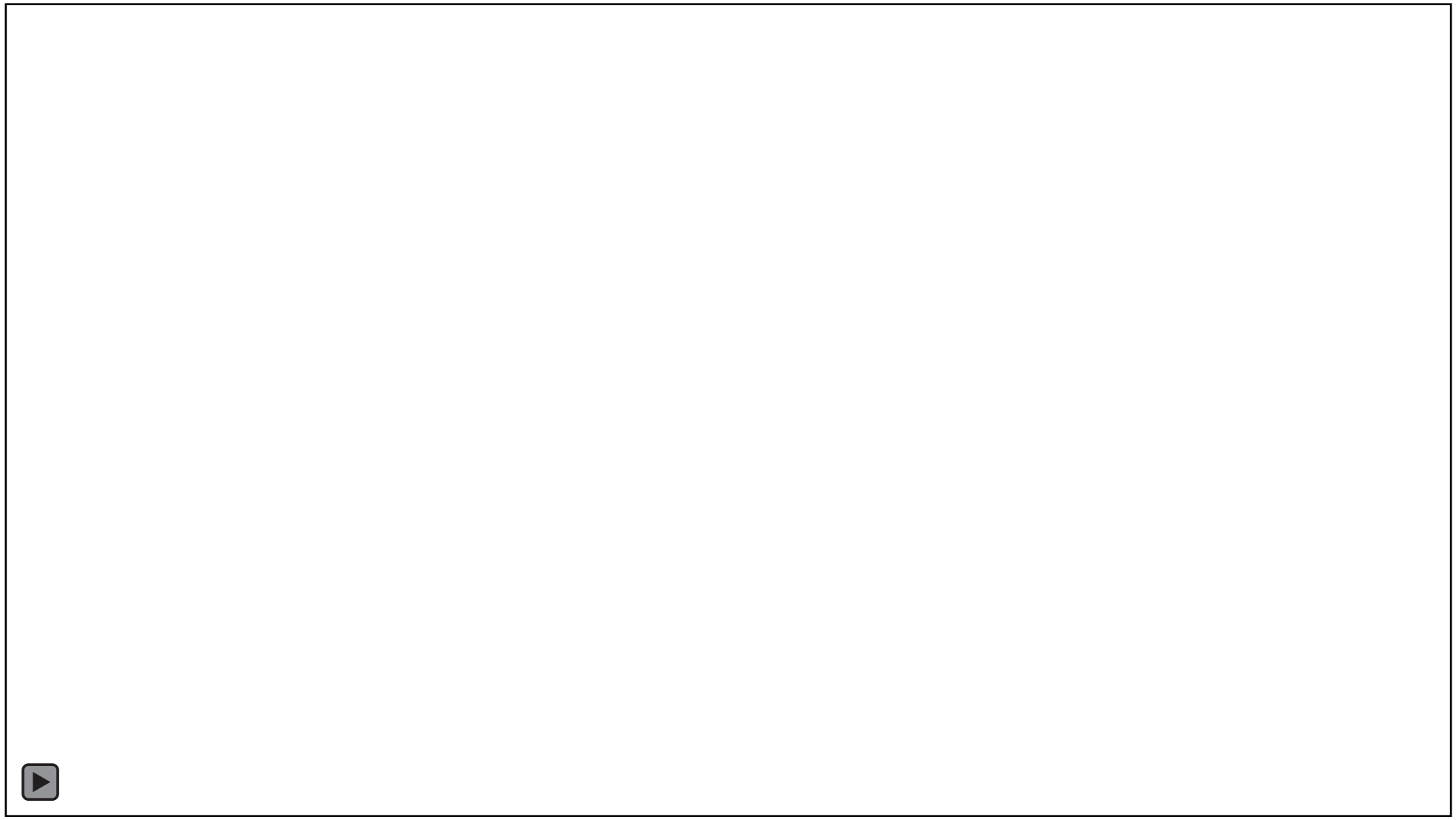


Pigments: Red, pink and purple EXBERRY® raw materials





Heat impact: EXBERRY® Shade Fiesta Pink



Heat impact: Red, pink and purple EXBERRY®

Product parameters: 8 °Brix
pH 3.0

- Red, pink and purple EXBERRY® containing **anthocyanin**-based raw materials are very stable against heat.

0.05 % EXBERRY® Shade Veggie Red | 0.05 % EXBERRY® Shade Vivid Red | 0.05 % EXBERRY® Shade Brilliant Pink | 0.05 % EXBERRY® Shade Purple Plum

Left Bottle: No heat treatment
Right Bottle: Heated for 2 min at 100 °C

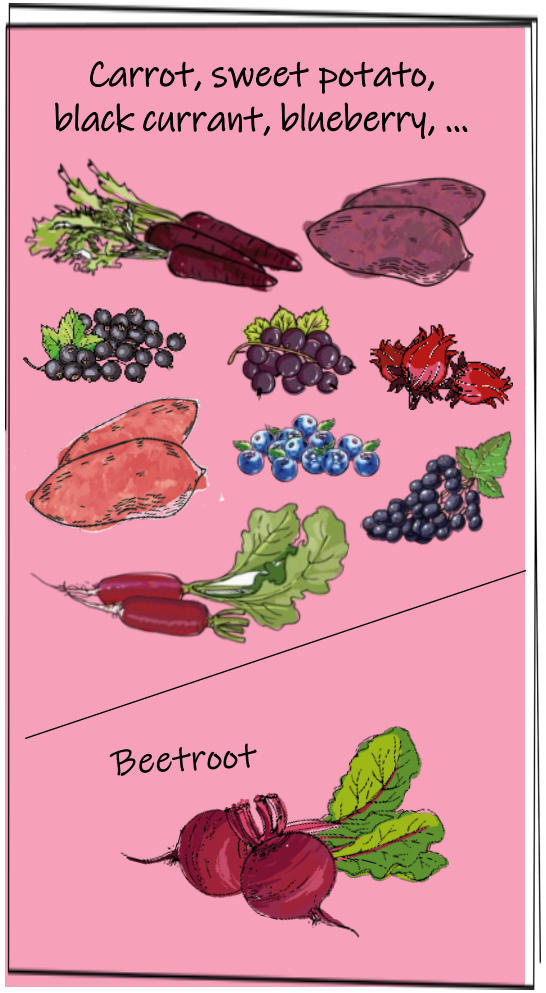
- EXBERRY® Shade Fiesta Pink which contains **beetroot (pigment: betanin)** is less heat stable.

0.20 % EXBERRY® Shade Fiesta Pink

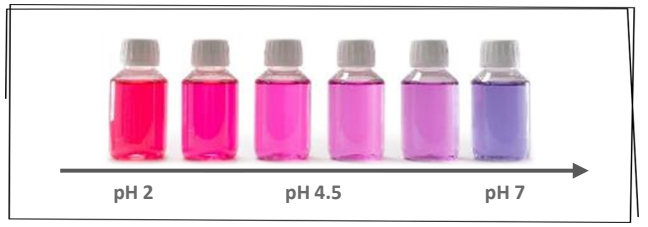
  - Ascorbic acid can help to reduce color loss of EXBERRY® Shade Fiesta Pink during pasteurization to some extent.

Color stability: Red, pink and purple EXBERRY®

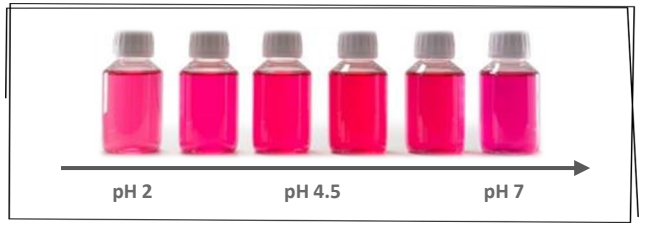
Raw materials



- Red, pink and purple EXBERRY® products made from raw materials containing **anthocyanins** are:
  - Heat stable
  - Light stable
  - pH dependent

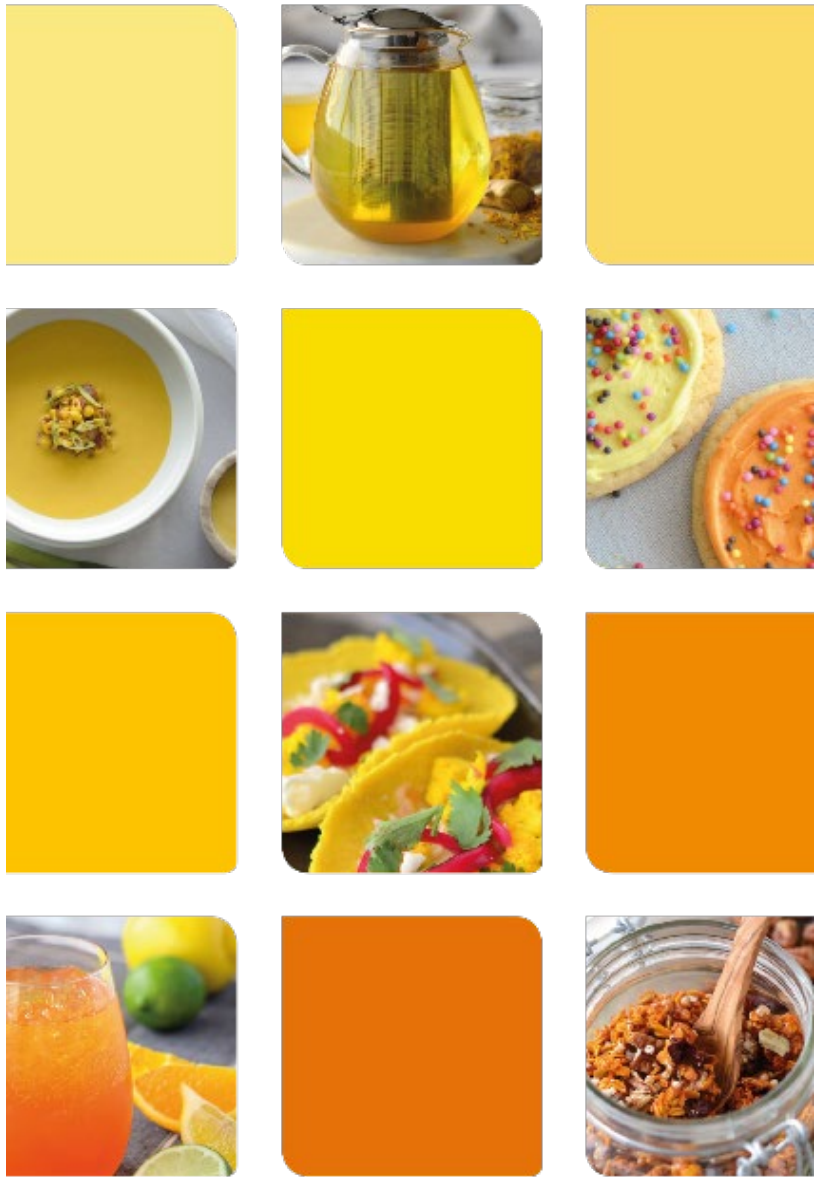


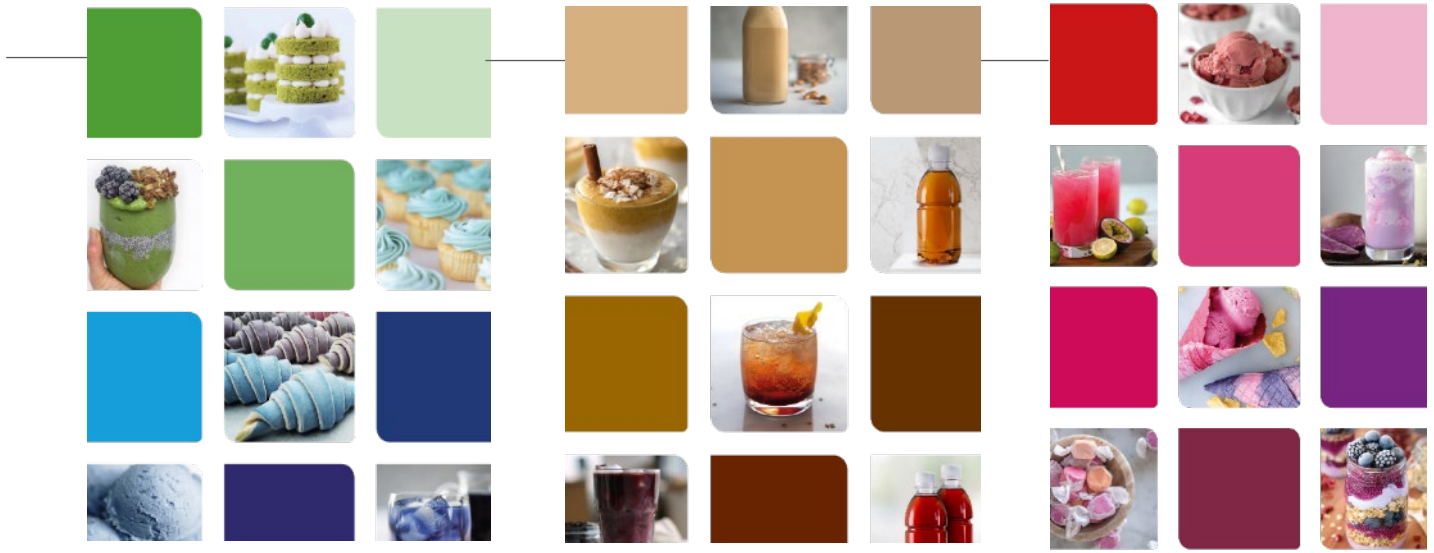
- Pink EXBERRY® products made from raw materials containing **betanin** are:
  - Less heat stable
  - Less light stable
  - pH independent



Light and heat stability can be improved with ascorbic acid addition.

Properties of YELLOW & ORANGE EXBERRY® Products





Yellow plant-based solutions

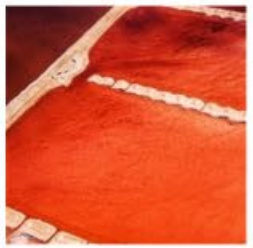
Raw materials


Carrot


Safflower


Turmeric


Pumpkin


Dunaliella Salina


Paprika


Annatto

Formats


Liquid concentrate


Powder


Micronized powder


Oil-soluble


Oil-dispersible

Applications


Bakery


Beverages


Savory


Confectionery


Cereals and snacks


Dairy


Plant-based


Ice cream

Overview: Yellow and orange EXBERRY® (1)

Product parameters: Buffer, pH 3.0 or invert sugar syrup

Clear EXBERRY®

0.03 % EXBERRY® **Shade Lemon Yellow** (safflower, lemon)

0.05 % EXBERRY® **Shade Orange - Stable** (radish, safflower)

0.05 % EXBERRY® **Shade Sunstone Orange** (sweet potato, safflower)

Cloudy EXBERRY®

0.05 % EXBERRY® **Shade Bright Yellow** (Turmeric)

0.17 % EXBERRY® **Shade Mango Yellow** (pumpkin, apple)

0.04 % EXBERRY® **Yellow Carotene**

0.13 % EXBERRY® **Shade Yellow - Cloudy** (carrot, pumpkin)

0.05 % EXBERRY® **Shade Vivid Orange** (paprika oil)

0.05 % EXBERRY® **Shade Brilliant Orange** (pepper, carrot)

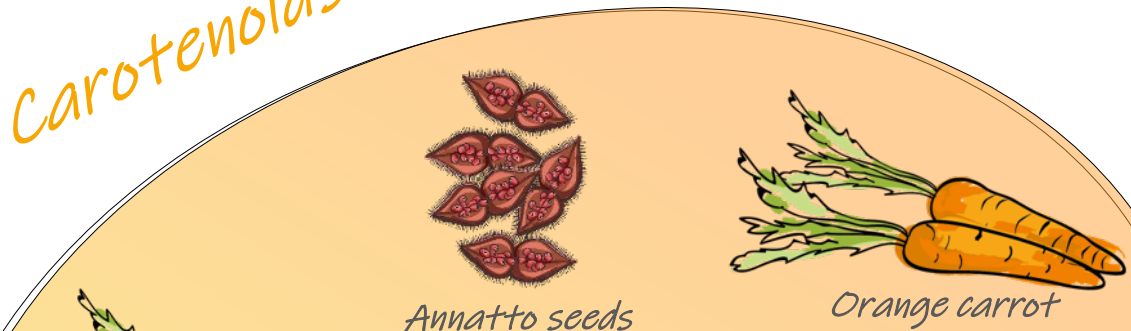
0.17 % EXBERRY® **Shade Mandarin** (carrot, apple)

- Clear EXBERRY® products are **completely water soluble**.
- Clear EXBERRY® products contain safflower as one raw material.

- Cloudy EXBERRY® products are not completely water soluble but **water dispersible**.
- Cloudy EXBERRY® products contain raw materials like pumpkin, carrot, turmeric, paprika or *Dunaliella Salina*.

Pigments: Yellow and orange EXBERRY® raw materials

Carotenoids


Annatto seeds

Orange carrot


Orange carrot
(turned yellow)


Dunaliella Salina


Paprika


Pumkin


Paprika seed oil

Curcuminoids


Turmeric

Safflomin A


Safflower

Red , pink and purple raw materials

EXBERRY®: Experiment

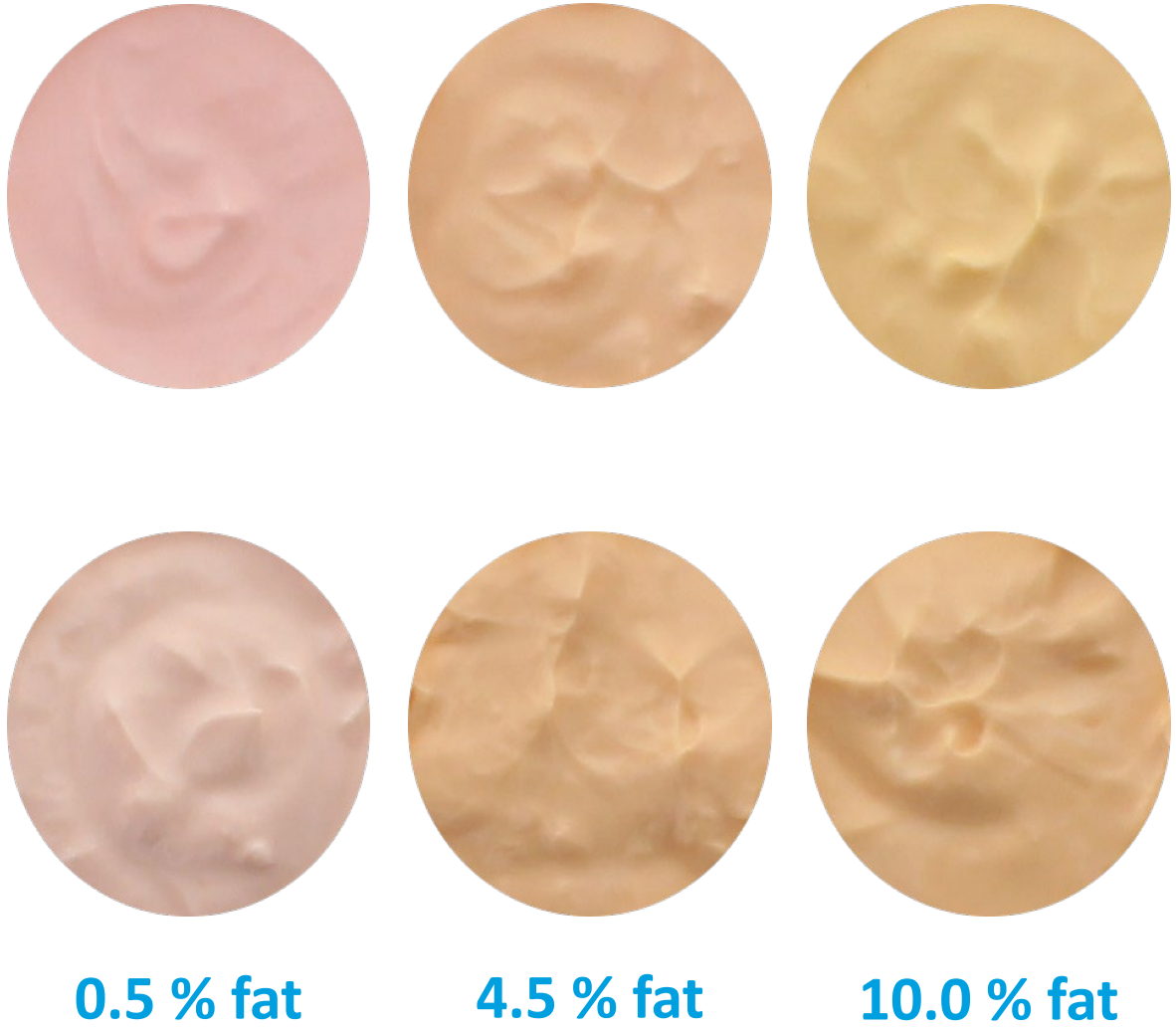
1. In front of you are three different cream cheese samples.
2. Add 10 drops of EXBERRY® Shade Mandarin to each sample and stir very well.

➢ What do you see?

Cream cheese with different fat contents

0.50 % EXBERRY®
Shade Mandarin

0.20 % EXBERRY® Shade
Brilliant Orange



0.5 % fat **4.5 % fat** **10.0 % fat**

Influence of pH value: Yellow EXBERRY®

0.03 % EXBERRY®
Shade Lemon Yellow
(safflower, lemon)

0.05 % EXBERRY®
Shade Bright Yellow
(Turmeric)

0.17 % EXBERRY®
Shade Mango Yellow
(pumpkin, apple)

0.13 % EXBERRY®
Shade Yellow - Cloudy
(carrot, pumpkin)

0.04 % EXBERRY®
Yellow Carotene

pH 2 pH 3 pH 4 pH 5 pH 6 pH 7

Yellow EXBERRY® products are not pH dependent.

Influence of pH value: Orange EXBERRY®

Cloudy orange EXBERRY®
(Shade Mandarin, Brilliant Orange, Vivid Orange)

Cloudy orange EXBERRY® products are not pH dependent.

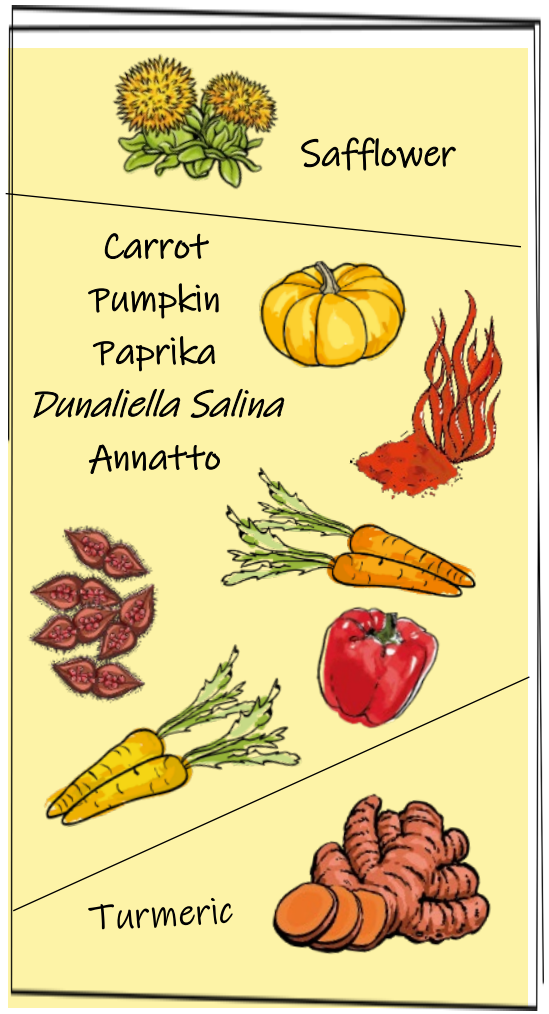
Clear orange EXBERRY®
(Shade Orange - Stable, Sunstone Orange)

Safflower

Raw material containing anthocyanins

Clear orange EXBERRY® products are pH dependent.

Color stability Yellow and orange EXBERRY®



- **Clear** yellow / orange EXBERRY® made from raw materials containing **safflomin A** (safflower) are:
  - Light and heat stable
  - pH dependent for orange EXBERRY®

- **Cloudy** EXBERRY® products made from raw materials containing **carotenoids** are:
  - Light stable (dependent on application)
  - Heat stable
  - pH independent

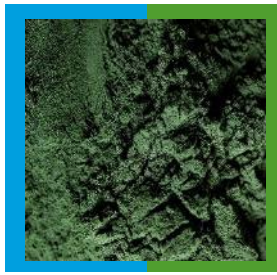
Light stability can be highly **improved** with **antioxidants** like ascorbic acid

- **Cloudy** EXBERRY® made from raw materials containing **curcuminoids** (turmeric) are:
  - Less light stable
  - Heat stable (heat can increase color intensity)
  - pH independent

Properties of BLUE & GREEN EXBERRY® Products

Blue and Green plant-based solutions

Raw materials

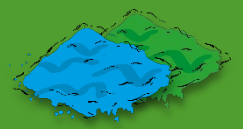

Spirulina


Safflower


Turmeric

Formats


Liquid concentrate


Powder


Micronized powder


Oil-dispersible

Applications


Bakery


Beverages


Savory


Confectionery

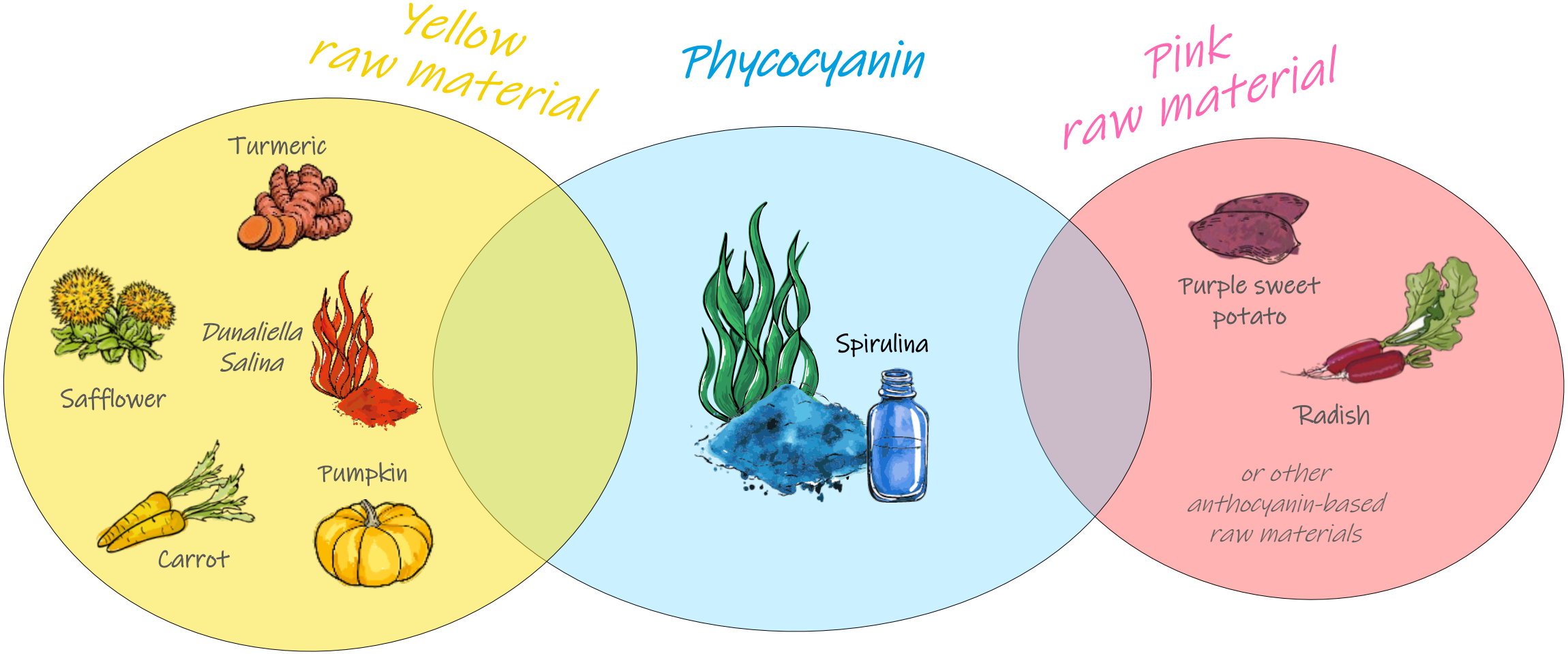

Cereals and snacks


Dairy


Plant-based


Ice cream

Pigments: Blue, green (and violet) EXBERRY® raw materials



Product overview

Product parameters: Buffer pH 7

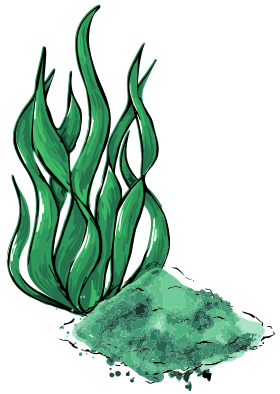
0.25% EXBERRY®
Shade Blue – HP
(spirulina)

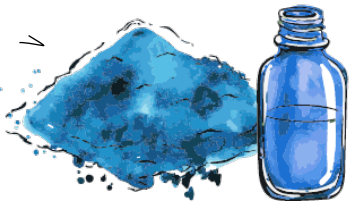
0.33% EXBERRY®
Shade Green
(spirulina, safflower)

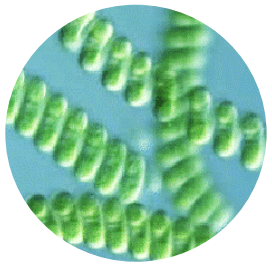
0.23% EXBERRY®
Shade Jade Green
(turmeric, spirulina)

0.23% EXBERRY®
Shade Lime Green
(turmeric, spirulina)

- All blue and green EXBERRY® products are **completely water soluble** or **water dispersible** depending on their raw material composition.
- The blue color is coming from the **Spirulina** algae*.
- Coloring pigment is called **phycocyanin**.



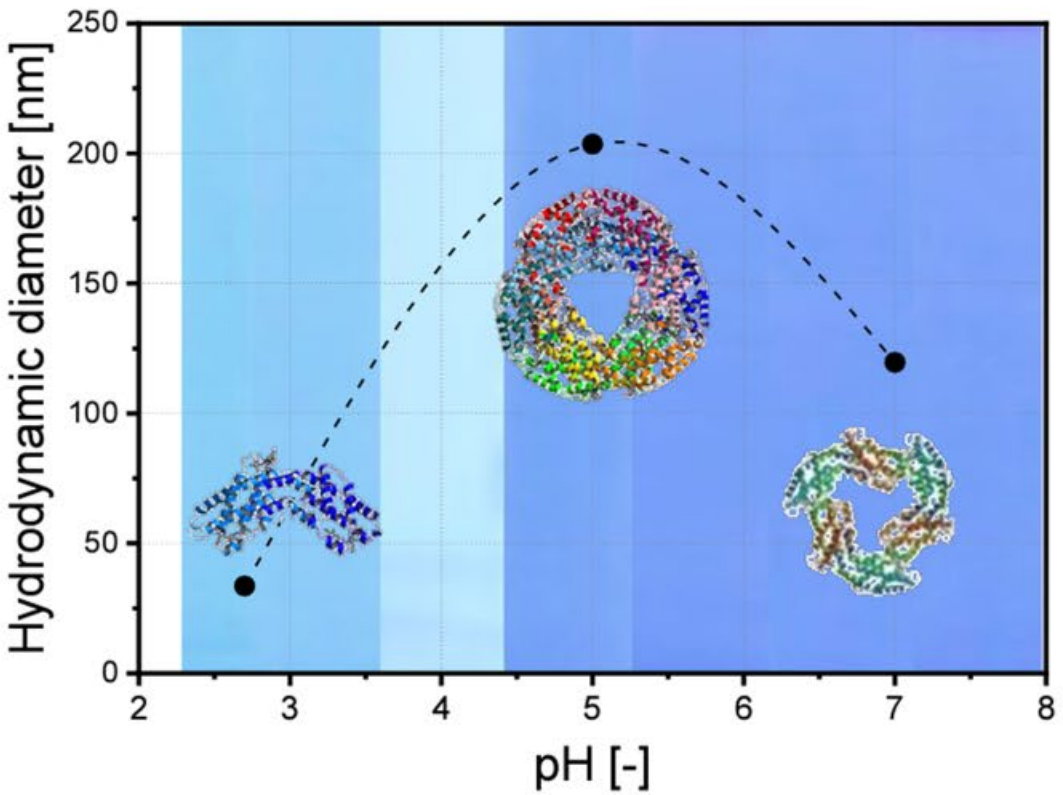




*The common name “Spirulina” refers to the dried biomass of *Arthrospira platensis.*

Blue & Green EXBERRY® products – Influence of pH value

Color shift and conformation change of C-phycocyanin



- Color shifts from purple blue to aqua blue as the pH value decreases due to the change in protein quaternary structure.

0.250%
Shade Blue- HP

0.125%
Shade Mint Green

0.230%
Shade Jade Green

0.230%
Shade Lime Green

EXBERRY®: Experiment

Part 1:

1. Mix 20 drops EXBERRY® Shade Blue - HP with a full pipette of citric acid solution (50 % w/w).
2. Add 200 mL invert sugar and mix again.

Part 2:

1. Mix 20 drops EXBERRY® Shade Blue - HP with 200 mL invert sugar.
2. Add a full pipette of citric acid solution and stir again.

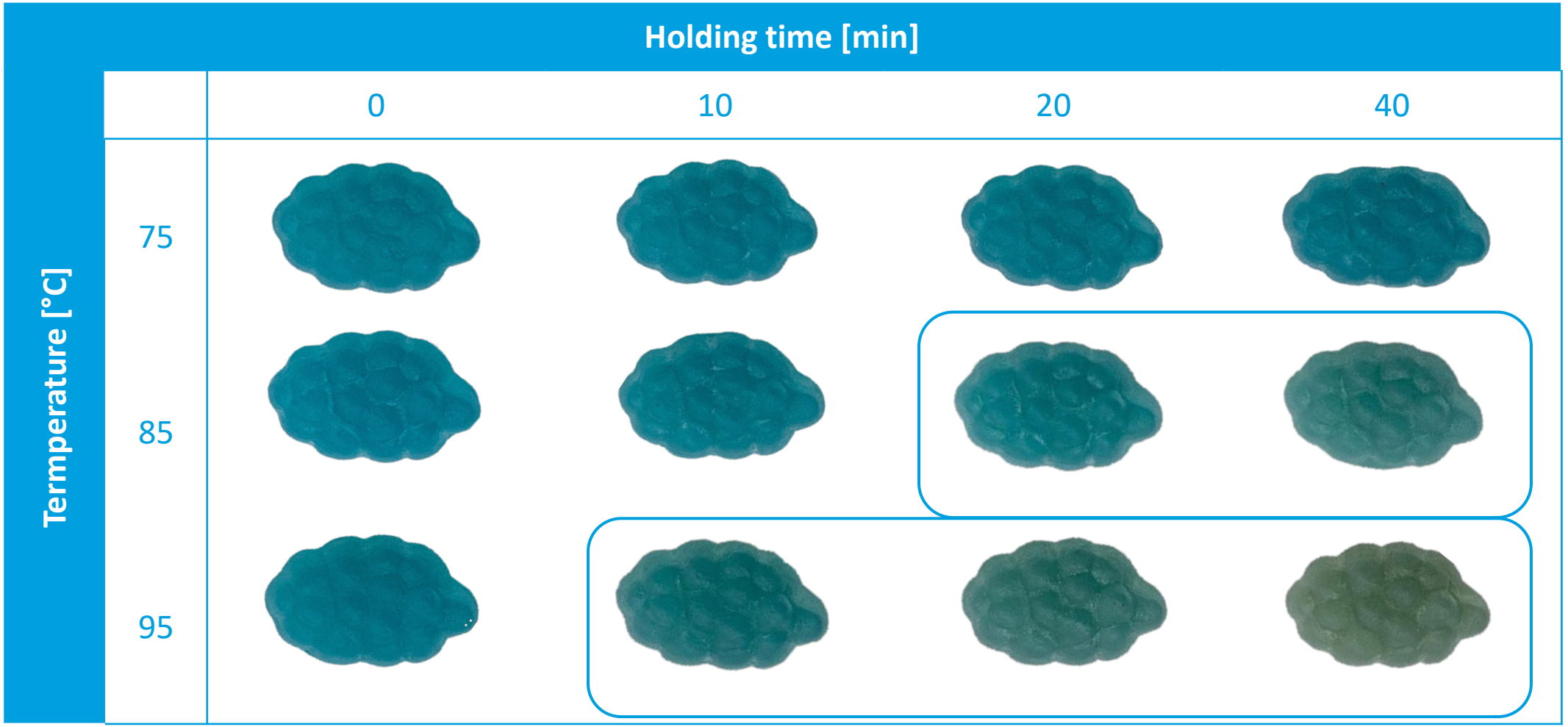
➢ What do you see?

Part 1 Part 2

- Direct contact of blue and green EXBERRY® with acids should be avoided.
- Blue and green EXBERRY® are sensitive to acid.

Video: Heat sensitivity of blue & green EXBERRY®

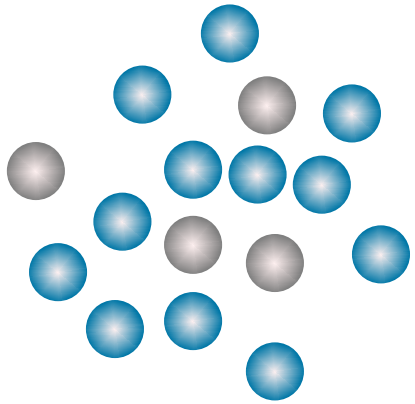
Comparison of holding times at different temperatures in starch gums



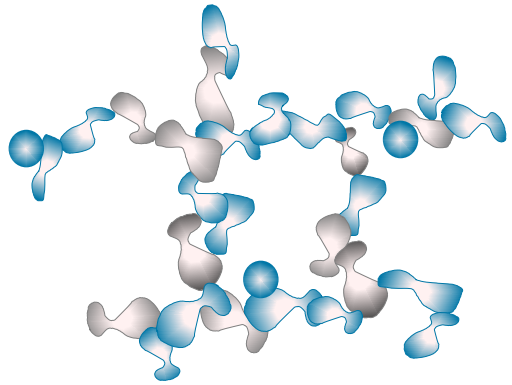
Visible change in color

- During the holding time at 85 °C and 95 °C isolated agglomeration formation has occured

Blue & Green EXBERRY® products – Challenges in application

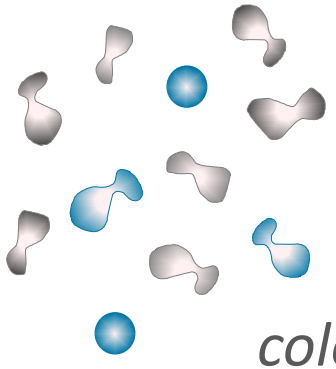


Protein concentration ↑ Temperature ↑



agglomeration

pH ↓ Temperature ↑

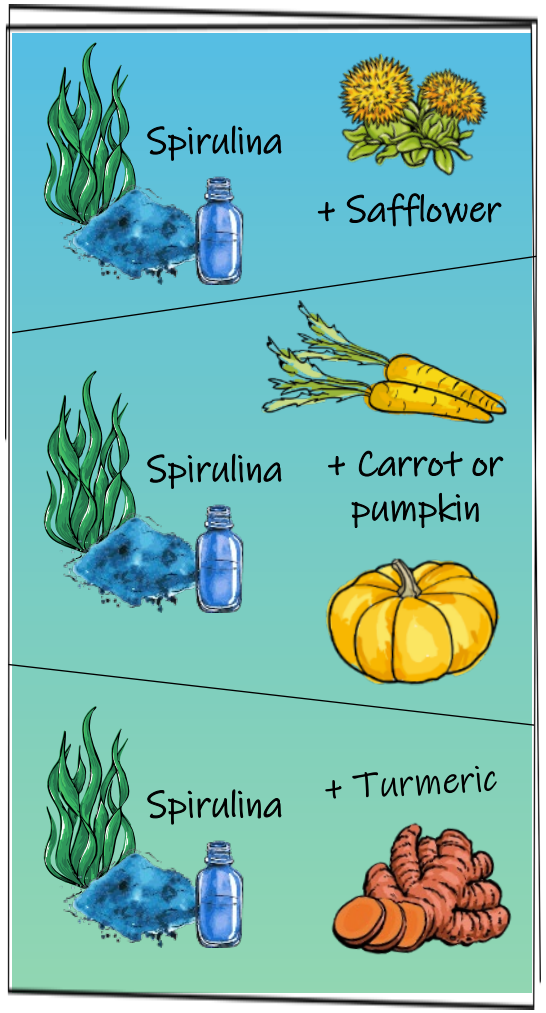


color fading

Color loss *Agglomeration*

Color stability: Blue and green EXBERRY®

Raw materials



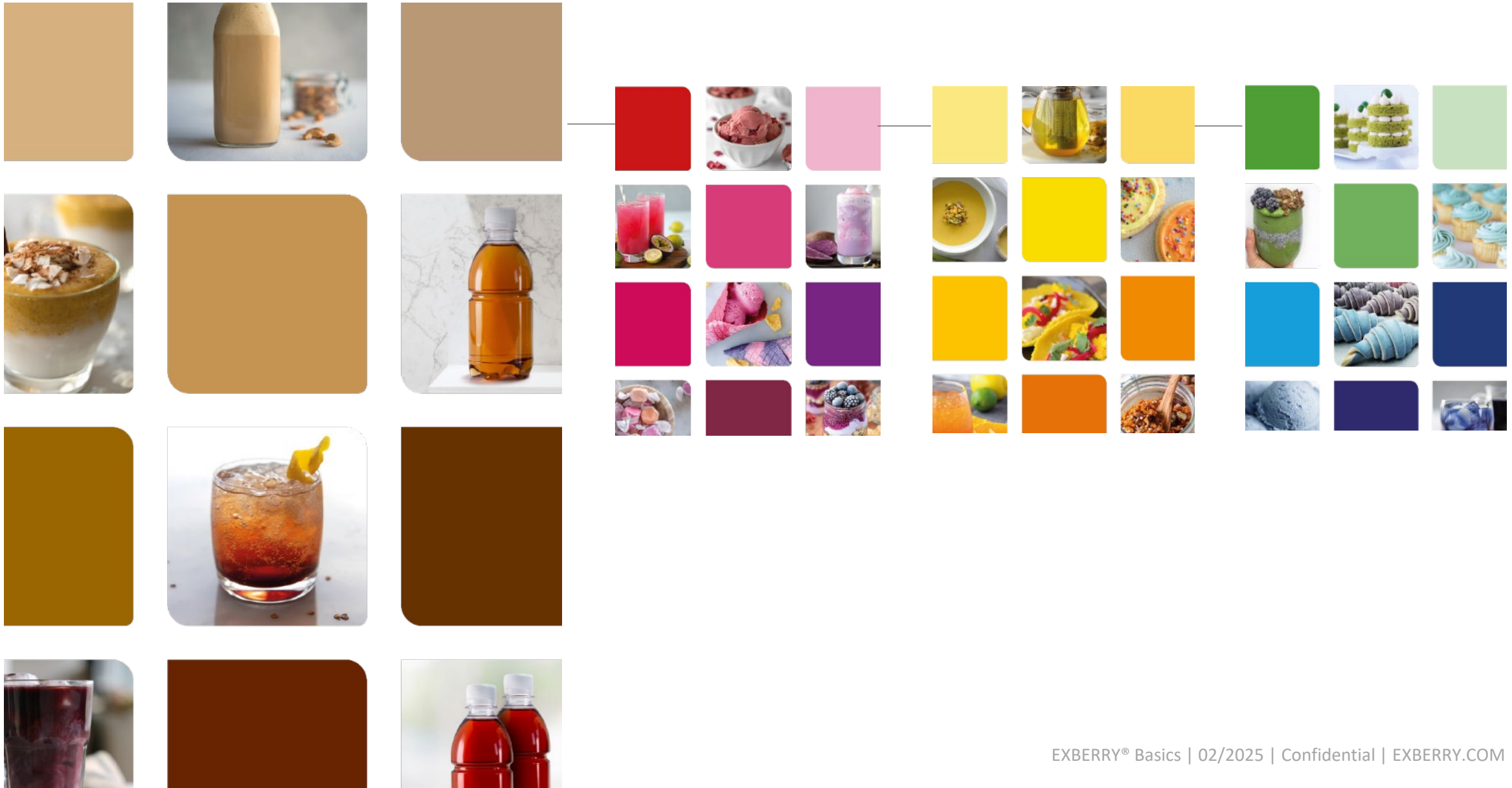
- **Clear** blue or green EXBERRY® made from raw materials containing **phycocyanin** (spirulina) and **safflomin A** (safflower) are:
  - Light stable
  - Heat and acid sensitive

- **Cloudy** green EXBERRY® products made from raw materials containing **phycocyanin** and **carotenoids** are:
  - Light stable (highly dependent on application)
  - Heat and acid sensitive

Light stability can be highly improved with antioxidants like **ascorbic acid**

- **Cloudy** green EXBERRY® made from raw materials containing **phycocyanin** and **curcuminoids** (turmeric) are:
  - Less light stable
  - Heat and acid sensitive

Properties of BROWN & BLACK EXBERRY® Products



Brown plant-based solutions

Raw materials

Orange carrot

Apple

Sugar beet

Formats

Liquid concentrate

Powder

Micronized powder

Applications

Bakery

Beverages

Savory

Confectionery

Cereals and snacks

Dairy

Plant-based

Overview: Brown EXBERRY®

Product parameters: Fruit gums, pH 3.2

Clear EXBERRY®

0.17 % EXBERRY®
Shade Golden Brown
(caramelized sugar syrup, apple)

0.17 % EXBERRY®
Shade Autumn Brown
(caramelized sugar syrup, carrot)

0.12 % EXBERRY®
Shade Brown - HP
(carrot, safflower, spirulina)

- Clear EXBERRY® products are completely **water soluble**.
- Shade Golden Brown and Autumn Brown are based on caramelized sugar syrup (and apple or carrot).
- Shade Brown - HP is a mix of purple carrot, safflower and spirulina concentrate.

Cloudy EXBERRY®

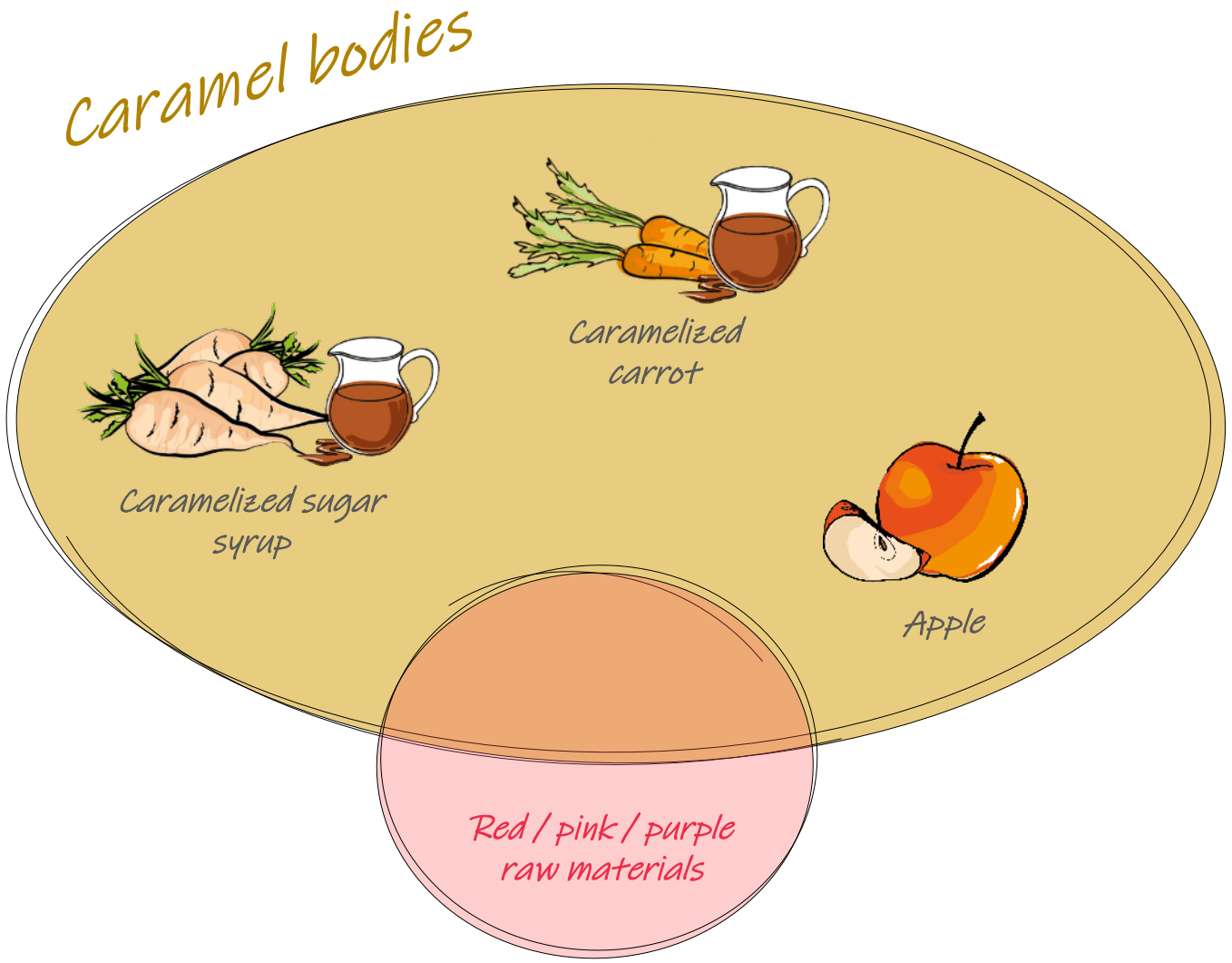
0.31 % EXBERRY®
Shade Russet Brown
(apple)

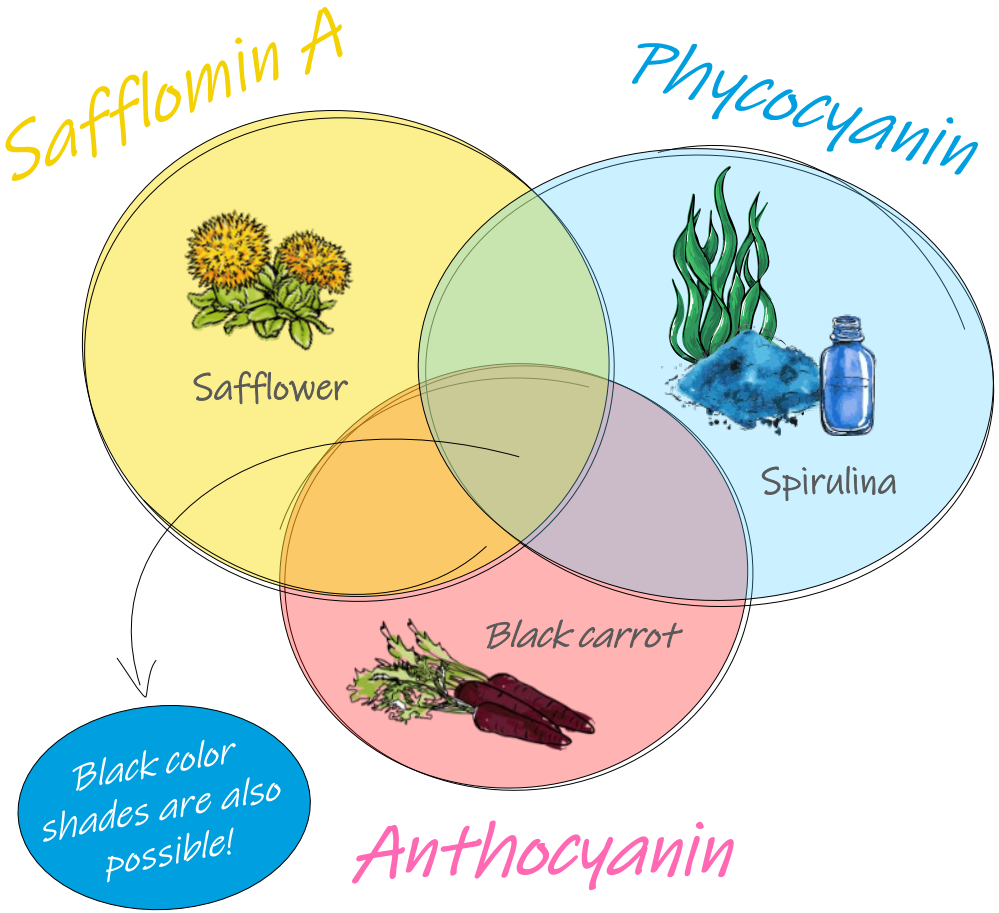
0.20 % EXBERRY®
Shade Brown
(caramelized carrot, carrot)

0.22 % EXBERRY®
Shade Dark Brown
(caramelized carrot, carrot)

- Cloudy EXBERRY® products are not completely water soluble but **water dispersible**.
- Shade Russet Brown is based on apple.
- Shade Brown and Dark Brown contain caramelized carrot and carrot.

Pigments: Brown EXBERRY® raw materials





Influence of pH value: Brown EXBERRY® (1)

0.09 % EXBERRY®
Shade Golden Brown
(caramelized sugar syrup, apple)

0.17 % EXBERRY®
Shade Russet Brown
(apple)

0.10 % EXBERRY®
Shade Brown
(caramelized carrot, carrot)

EXBERRY® Shade Golden Brown, Russet Brown and Brown are not pH dependent.

Influence of pH value: Brown EXBERRY® (2)

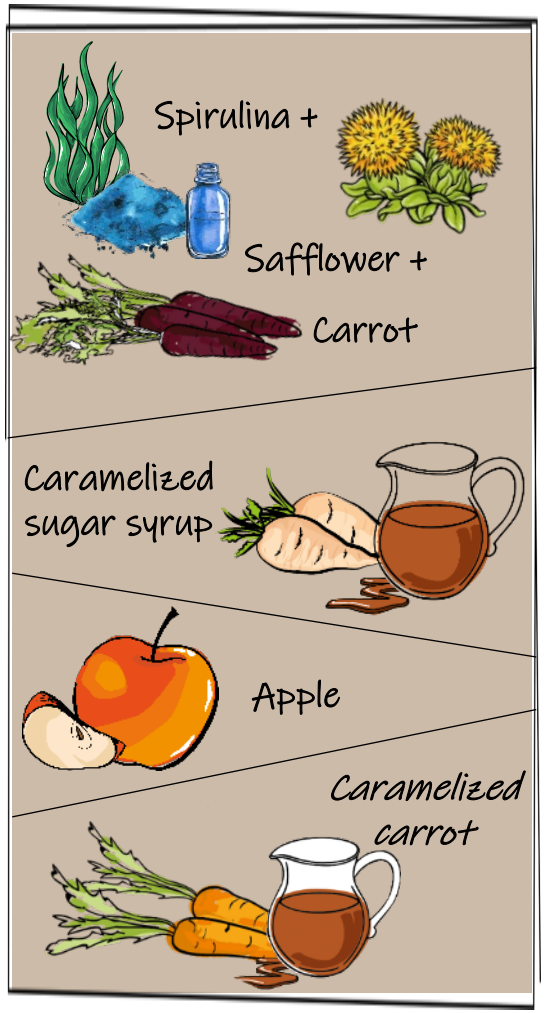
0.09 % EXBERRY®
Shade Autumn Brown
(caramelized sugar syrup, carrot)

0.12 % EXBERRY®
Shade Brown - HP
(carrot, safflower, spirulina)

0.22 % EXBERRY®
Shade Dark Brown
(caramelized carrot, carrot)

EXBERRY® Shade Autumn Brown, Brown - HP and Dark Brown are pH dependent.

Color stability: Brown EXBERRY®



- **Clear** brown EXBERRY® products made from raw materials containing **safflomin A, anthocyanins and phycocyanin** are:
  - Light stable
  - Heat sensitive
  - Acid sensitive and pH dependent

- **Clear or cloudy** brown EXBERRY® made from **caramelized sugar syrup, apple** or **caramelized carrot** are:
  - Light stable
  - Heat stable
  - pH independent

GNT also offers products with a more chocolate brown color shade. These have additional black carrot and are therefore pH dependent.

EXBERRY® in fat-based applications

GROWING COLORS EXBERRY®

Higher “color yield” with EXBERRY® MN - Powder

OD

2.2% EXBERRY®
Shade Yellow – OD

(CI in application: 9.9)

MN

1.0% EXBERRY®
Shade Yellow – MN Powder

(CI in application: 10)

55% less dosage, but equal color intensity

OD

2.5% EXBERRY® Shade Blue - OD
+ 2.4% EXBERRY® Shade Yellow – OD

CI blue part in application: 1.5
CI yellow part in application: 10.8)

MN

1.5% EXBERRY®
Shade Green – MN Powder

(CI blue part in application: 1.5
CI yellow part in application: 9.8)

69% less dosage, but equal color intensity

OD

1.5% EXBERRY®
Shade Red – OD

(CI in application: 6)

MN

0.6% EXBERRY®
Shade Red – MN Powder

(CI in application: 6)

OD

5.0% EXBERRY® Shade Blue - OD

(CI part in application: 3)

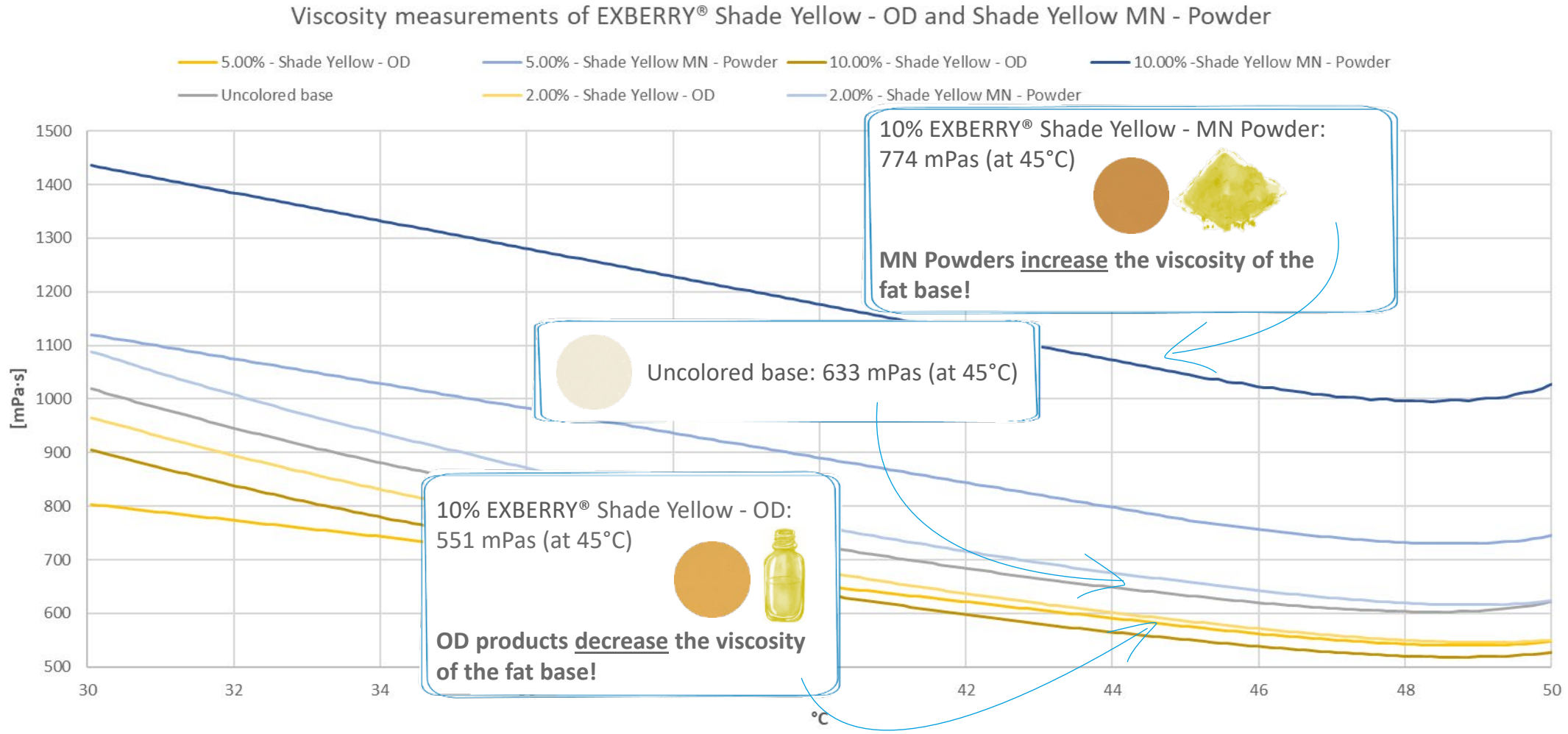
MN

2.0% EXBERRY®
Shade Blue – MN Powder

(CI n application: 1.5)

60% less dosage, but equal color intensity

Influence of high dosed OD and MN Powders on viscosity



Interactions with EXBERRY®

Interactions Part I – Background color

EXBERRY®: Experiment

1. Add a drop of EXBERRY® Shade Brilliant Pink to each bottle.
2. Shake well.

➢ **What do you see?**

- With the addition of juices to your drink you add:
  - Sugars and **acids**
  - Vitamins and **minerals**
  - **Background color**
  - Cloudiness (e.g. orange juice, pineapple juice)

Clear Base

pH 3.4

30% Apple Juice

pH 3.4

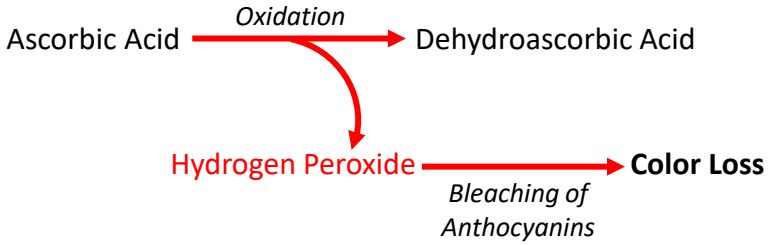
0.05% EXBERRY®
Shade Brilliant Pink

Interactions Part II – Ascorbic acid

Influence of ascorbic acid: Red EXBERRY® products

Product parameters: 8° Brix
pH 3.0
Cold preserved

- Ascorbic acid oxidation products can **irreversible bleach anthocyanins**.



- When using ascorbic acid and **anthocyanin**-based EXBERRY® in a drink:

1. Keep the technological necessary dose of ascorbic acid as low as possible (GMP).
2. Avoid very low EXBERRY® levels.
3. Remember that ascorbic acid can also be added via fruits (e.g. acerola, citrus).
4. Avoid high vitamin C claims. Ascorbic acid is often overdosed to ensure that the claimed dosage is still present at the expiration date.
5. Shorter best before dates are preferred to longer ones.

- Heat, time and oxygen level are the main factors promoting color degradation.
- Vegetable based EXBERRY® concentrates are more stable than fruit concentrates (e.g. elderberry).

Influence of ascorbic acid: Red EXBERRY® products

Product parameters: 8 °Brix
pH 3.0

- **Beetroot**-containing EXBERRY® (Shade Fiesta Pink) are very heat sensitive, especially with high temperature or long time.
- Ascorbic acid will reduce color loss during pasteurization to some extent.
- Nevertheless, color loss over shelf life will be still **worse** compared to all other red, pink and purple EXBERRY® products at. Those should be preferred in low-pH beverage applications.

No Ascorbic Acid

Unheated | Pasteurization 96°C, 30s | Heat Test 35°C, 7d

0.05% Ascorbic Acid

Unheated | Pasteurization 96°C, 30s | Heat Test 35°C, 7d

0.05% EXBERRY® Shade Fiesta Pink

Influence of ascorbic acid: Yellow and orange EXBERRY®

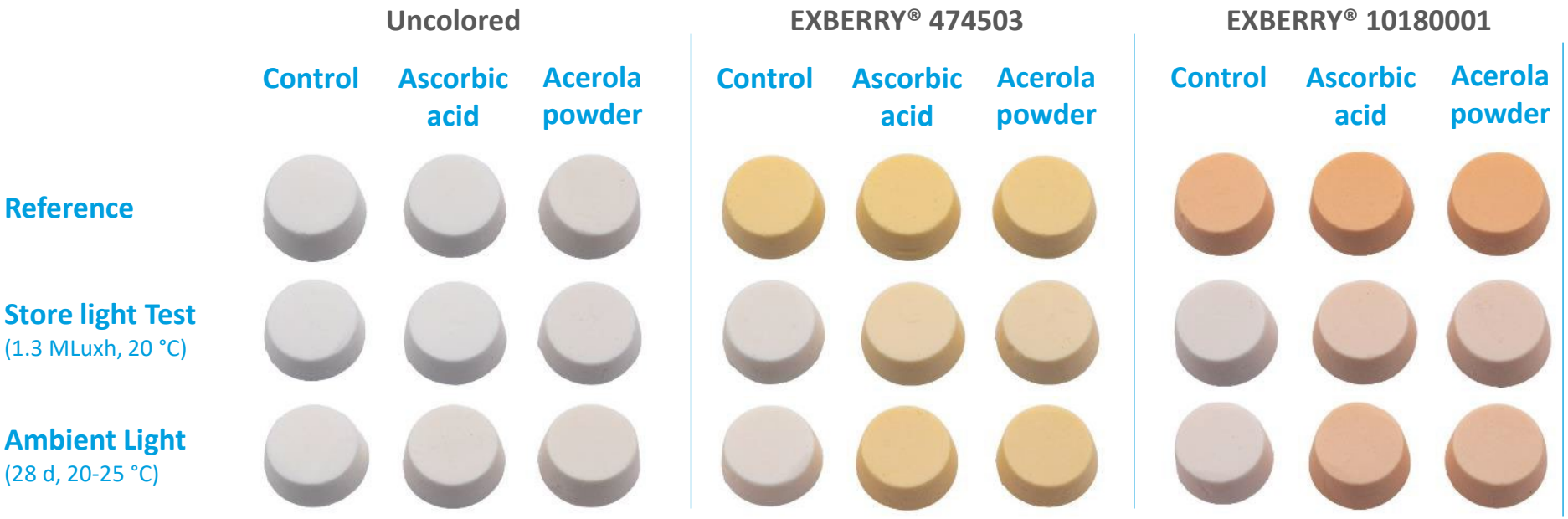
Product parameters: 8° Brix
pH 3.0
Cold preserved

- Ascorbic acid prevents **carotenoid**-based EXBERRY® products from oxidation.
- It has no influence on EXBERRY® Shade Lemon Yellow and Bright Yellow.

➢ When using ascorbic acid and **carotenoid**-based EXBERRY® products in a drink:

1. Ascorbic acid is needed, especially when using clear packaging.
2. The amount of ascorbic acid depends on the EXBERRY® product, intended shelf life and processing.
3. Recommended dosage levels:
   - ➢ 300-400 ppm for EXBERRY® Shade Yellow – Cloudy
   - ➢ 250-300 ppm for EXBERRY® Shade Mandarin

Carotenoid-based EXBERRY® in aerated fruit gums



- The addition of ascorbic acid or acerola powder has a protective effect on the light stability of carotenoid-based EXBERRY® products in aerated fruit gums

Interactions Part III – Light

Influence of the light source on color appearance

0.03 % EXBERRY® Shade
Brilliant Pink

Verivide Viewing Cabinet

Interactions Part II – Layer

Influence of the layer thickness on color appearance

Product parameters: 8 °Brix
pH 3.0
Cold preserved

0.033% EXBERRY®
Shade Brilliant Pink

GROWING COLORS EXBERRY®

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