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.

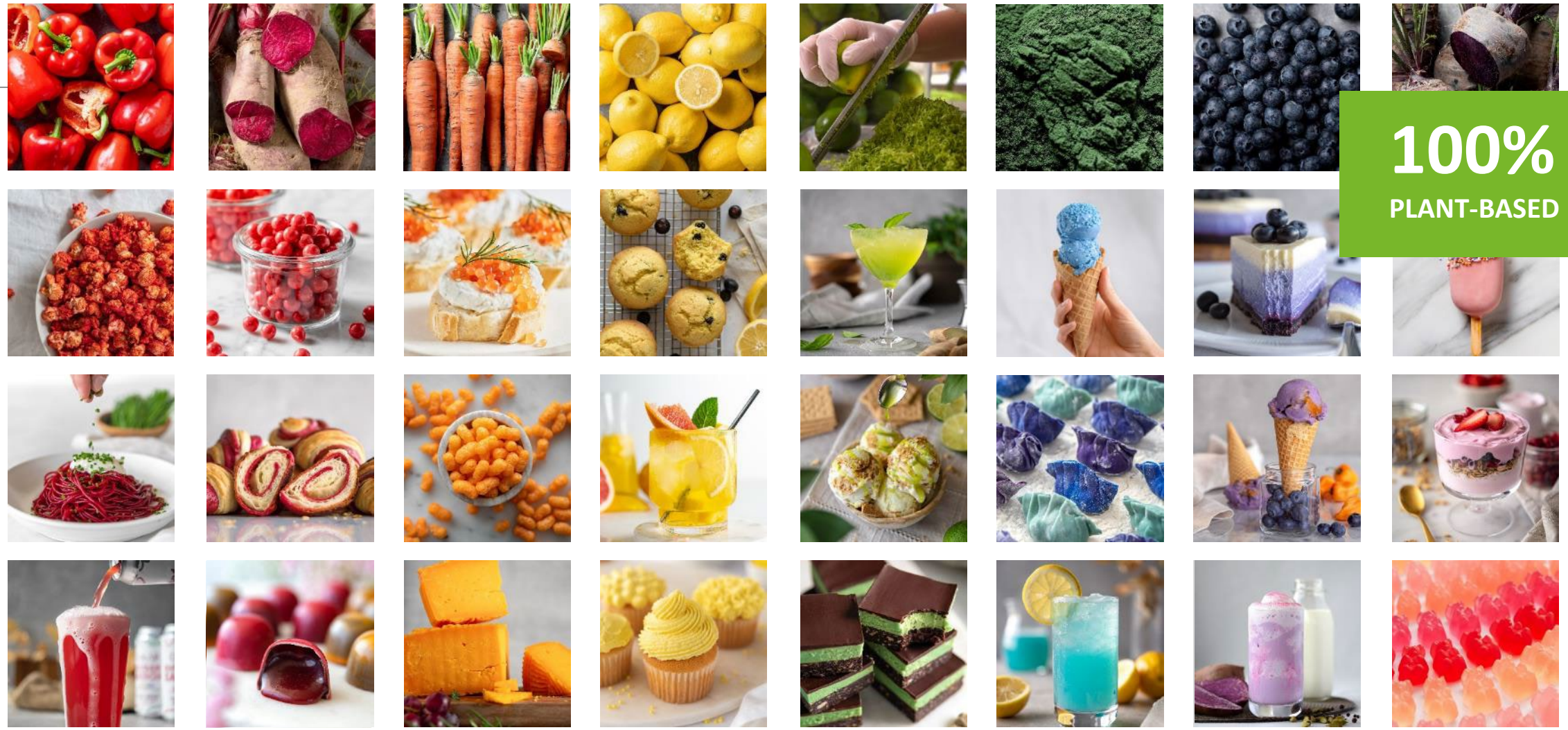
GROWING COLORS EXBERRY®

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®

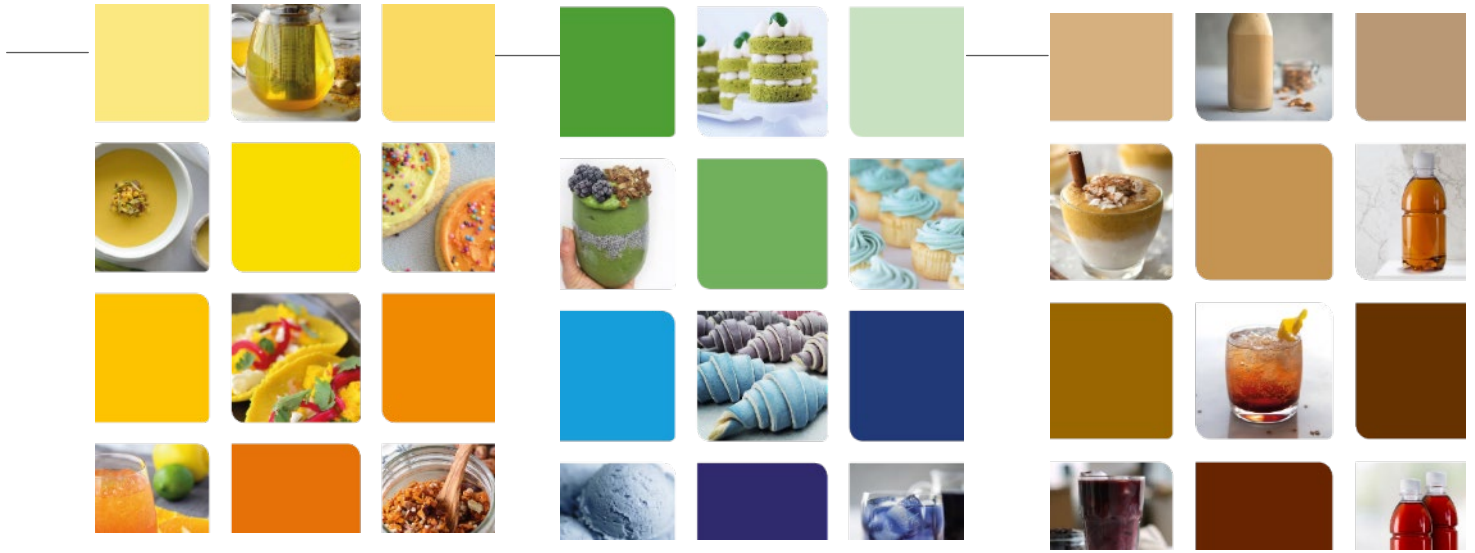
Red, Pink and Purple

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.

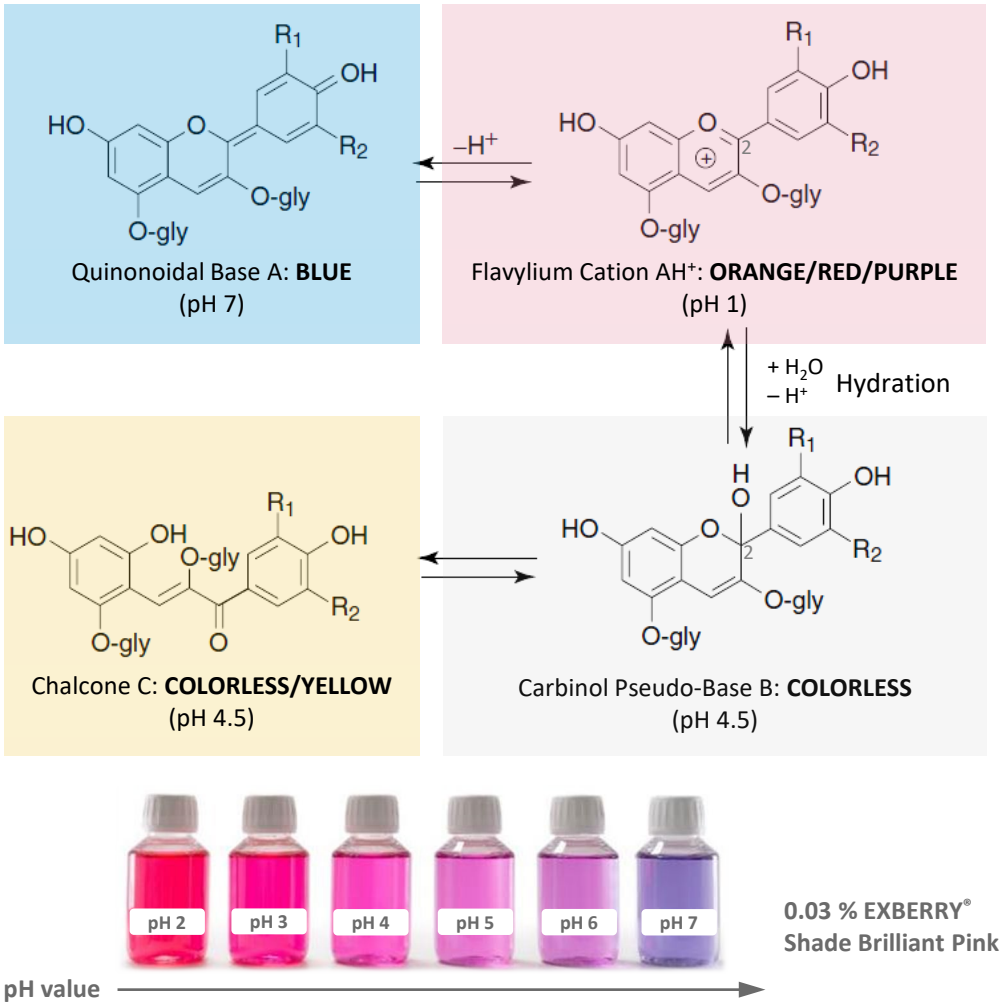
3. Add **a whole pipette** of citric acid solution to the beaker and mix.

   Take a sample.

➢ What do you see?

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

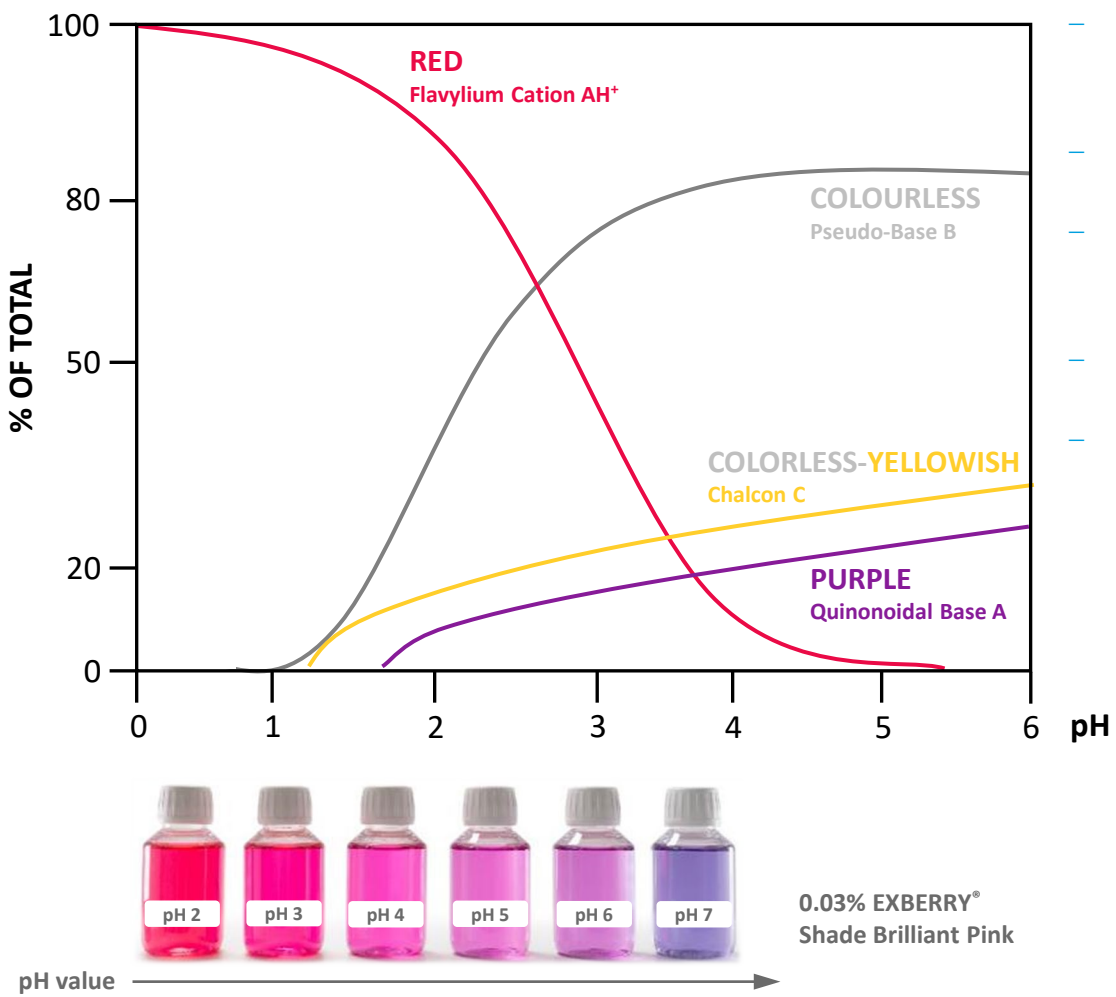
- Transformation of **anthocyanins** at different pH values



- 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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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)

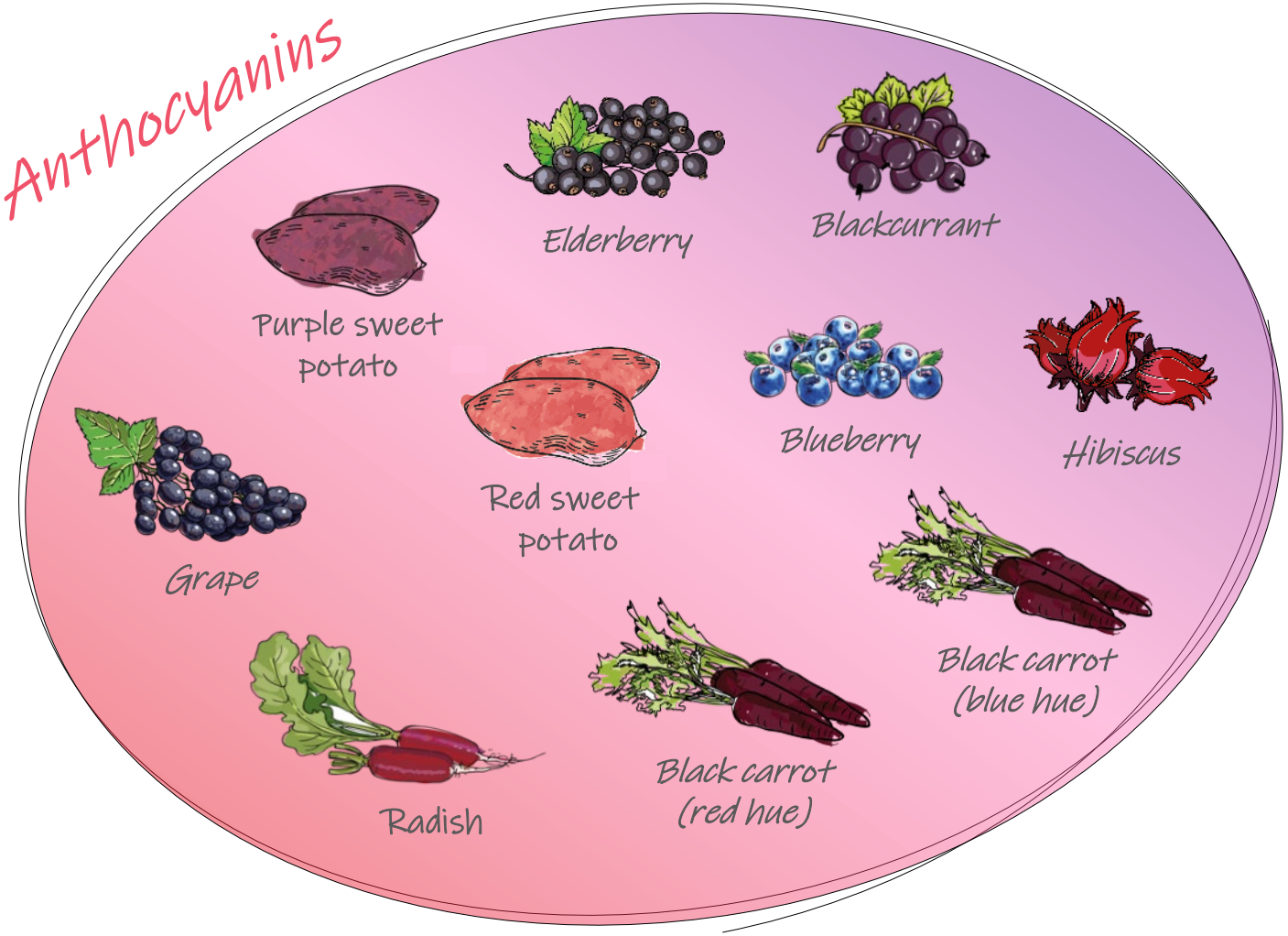
0.03% EXBERRY® Shade Purple Plum
(Carrot, blueberry)

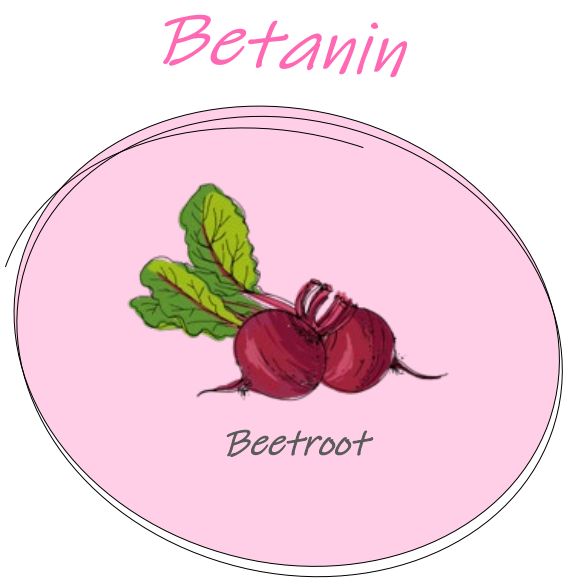
0.13% EXBERRY® Shade Fiesta Pink
(Beetroot, carrot)

EXBERRY® made from beetroot are not pH dependent.

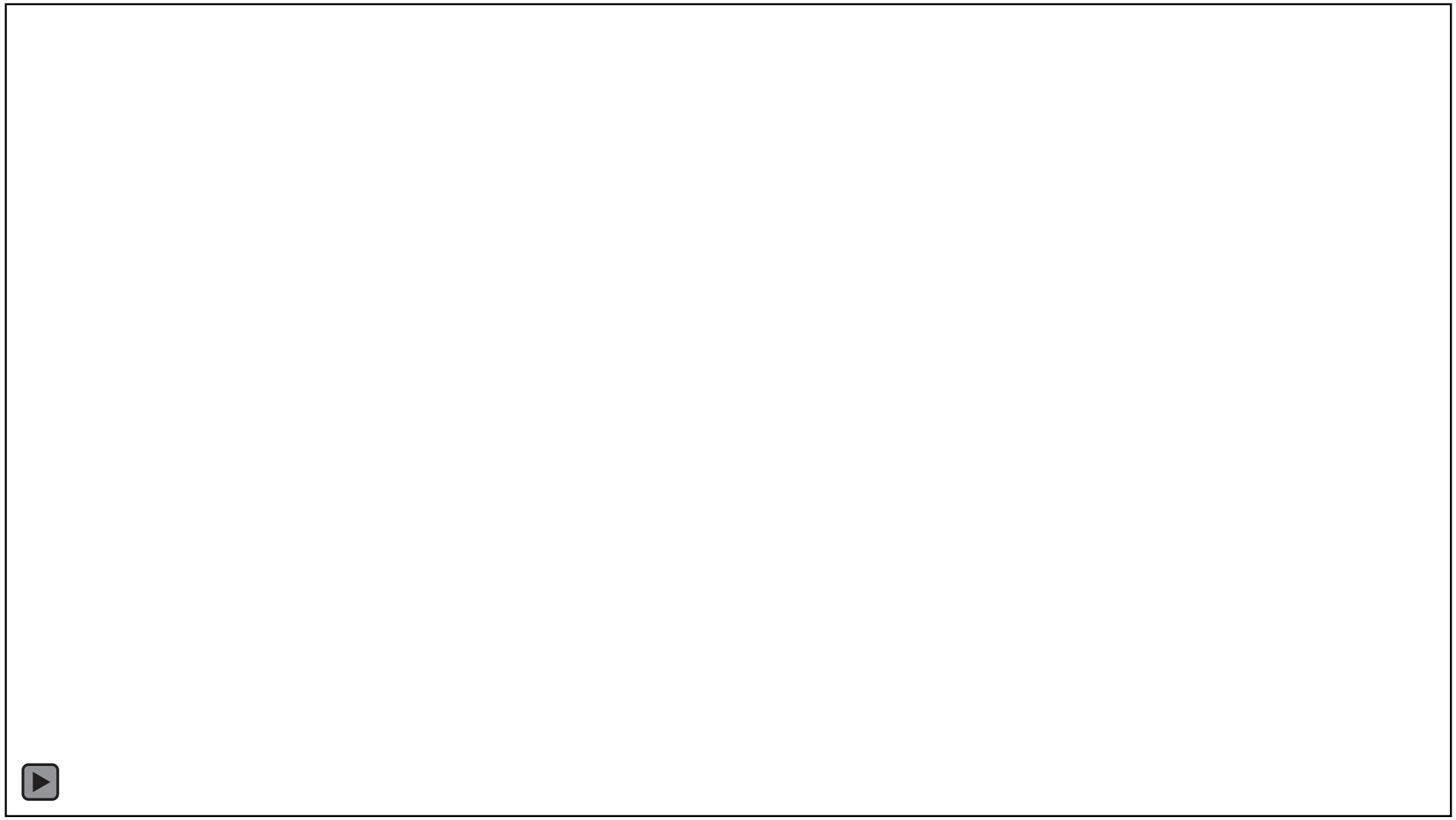
EXBERRY® products made from red fruits and vegetables that contain anthocyanins are pH dependent.

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

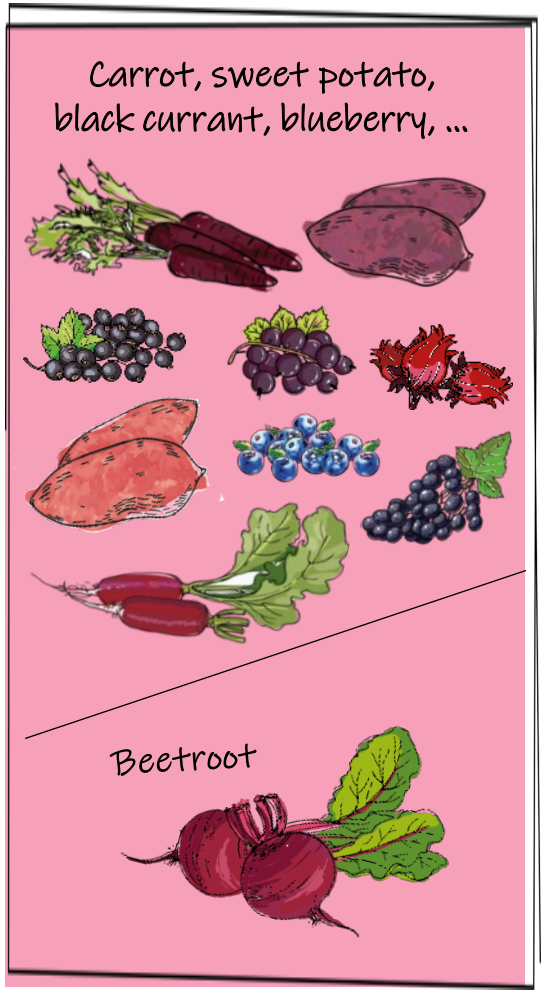
- EXBERRY® Shade Fiesta Pink which contains **beetroot (pigment: betanin)** is less heat stable.

0.20 % EXBERRY® Shade Fiesta Pink

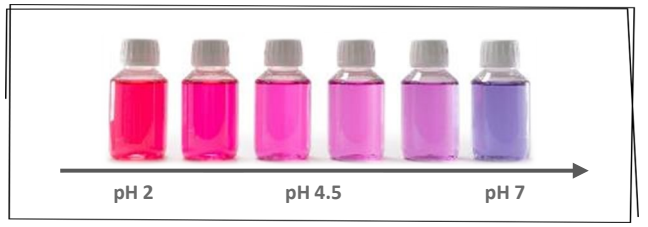
  - Ascorbic acid can help to reduce color loss of EXBERRY® Shade Fiesta Pink during pasteurization to some extent.

Color stability: Red, pink and purple EXBERRY®

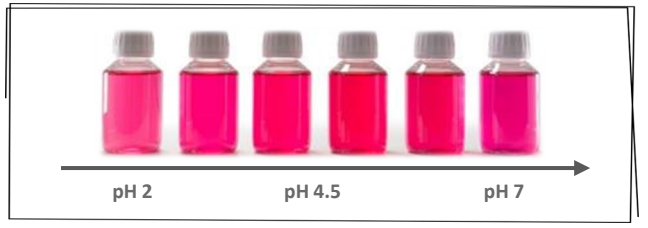
Raw materials



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

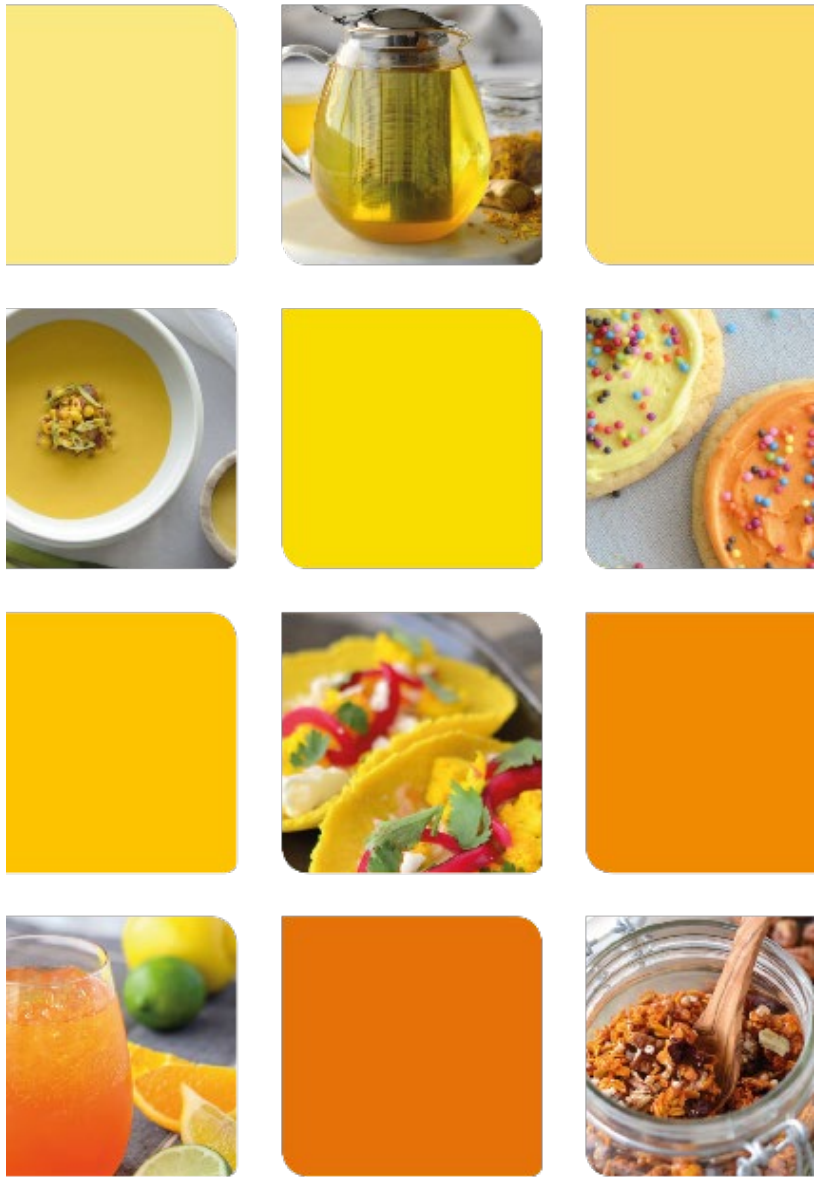


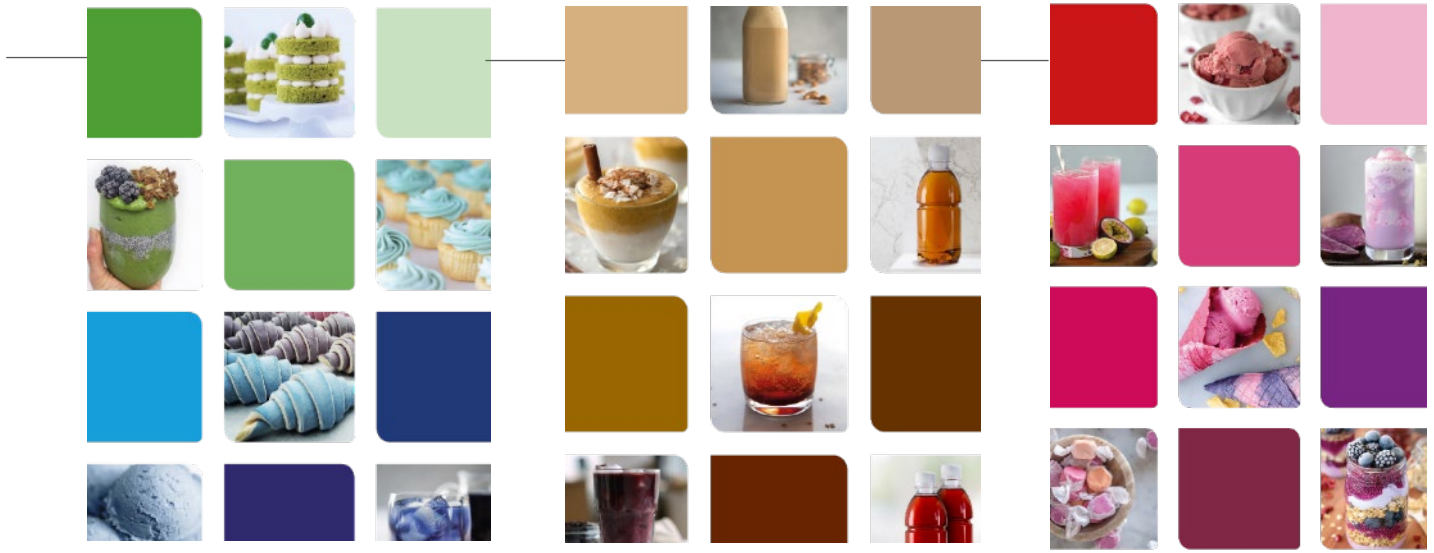
- Pink EXBERRY® products made from raw materials containing **betanin** are:
  - Less heat stable
  - Less light stable
  - pH independent



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

Properties of YELLOW & ORANGE EXBERRY® Products





Yellow plant-based solutions

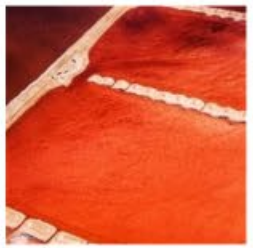
Raw materials


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.

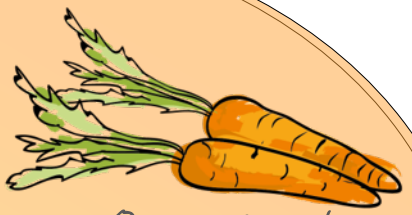
- Cloudy EXBERRY® products are not completely water soluble but **water dispersible**.
- Cloudy EXBERRY® products contain raw materials like pumpkin, carrot, turmeric, paprika or *Dunaliella Salina*.

Pigments: Yellow and orange EXBERRY® raw materials

Carotenoids


Orange carrot (turned yellow)


Annatto seeds


Orange carrot


Dunaliella Salina


Paprika


Pumkin


Paprika seed oil

Curcuminoids


Turmeric

Safflomin A


Safflower

Red , pink and purple raw materials

EXBERRY®: Experiment

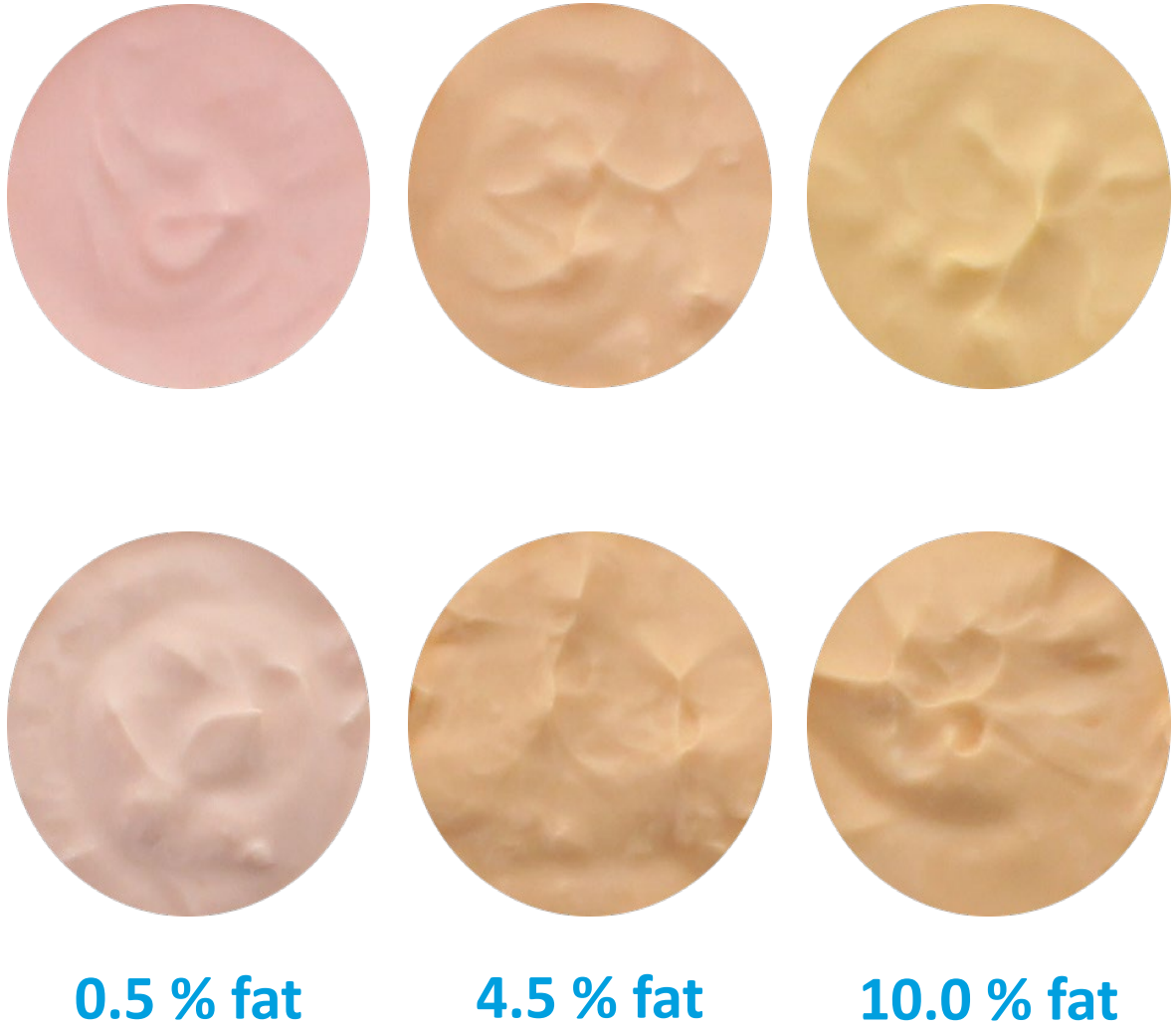
1. In front of you are three different cream cheese samples.
2. Add 10 drops of EXBERRY® Shade Mandarin to each sample and stir very well.

➢ 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)

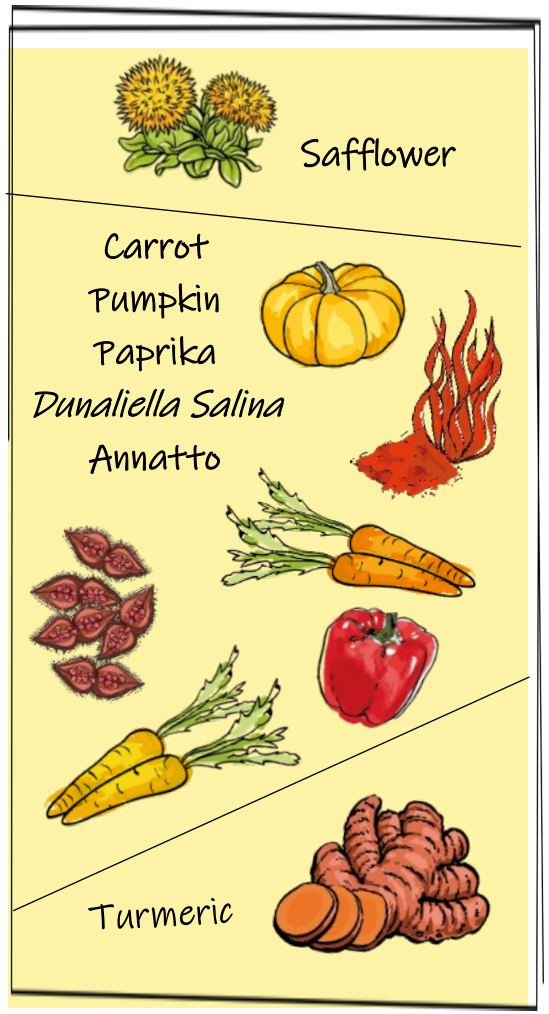
Safflower

Raw material containing anthocyanins

Clear orange EXBERRY® products are pH dependent.

Color stability Yellow and orange EXBERRY®

Raw materials



- **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

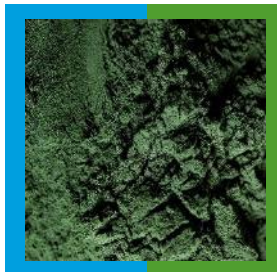
Light stability can be highly **improved** with **antioxidants** like ascorbic acid

- **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

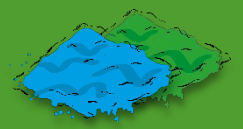

Spirulina


Safflower


Turmeric

Formats


Liquid concentrate


Powder


Micronized powder


Oil-dispersible

Applications


Bakery


Beverages


Savory


Confectionery

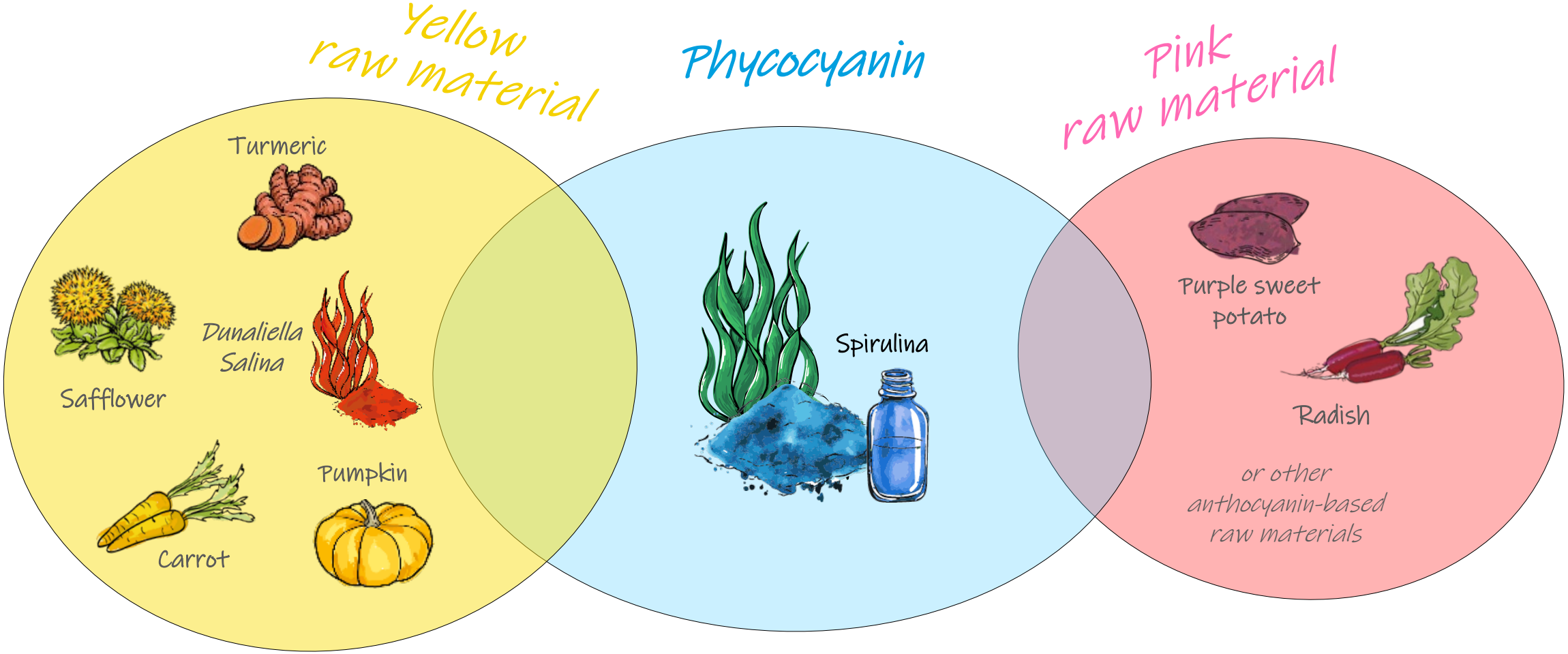

Cereals and snacks


Dairy


Plant-based


Ice cream

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



Product overview

Product parameters: Buffer pH 7

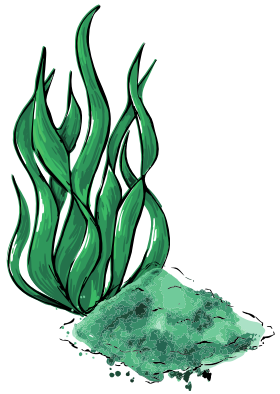
0.25% EXBERRY®
Shade Blue – HP
(spirulina)

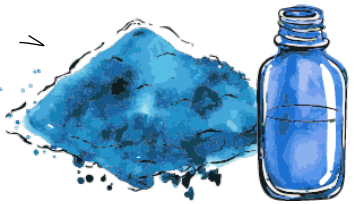
0.33% EXBERRY®
Shade Green
(spirulina, safflower)

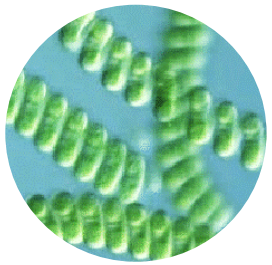
0.23% EXBERRY®
Shade Jade Green
(turmeric, spirulina)

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**.



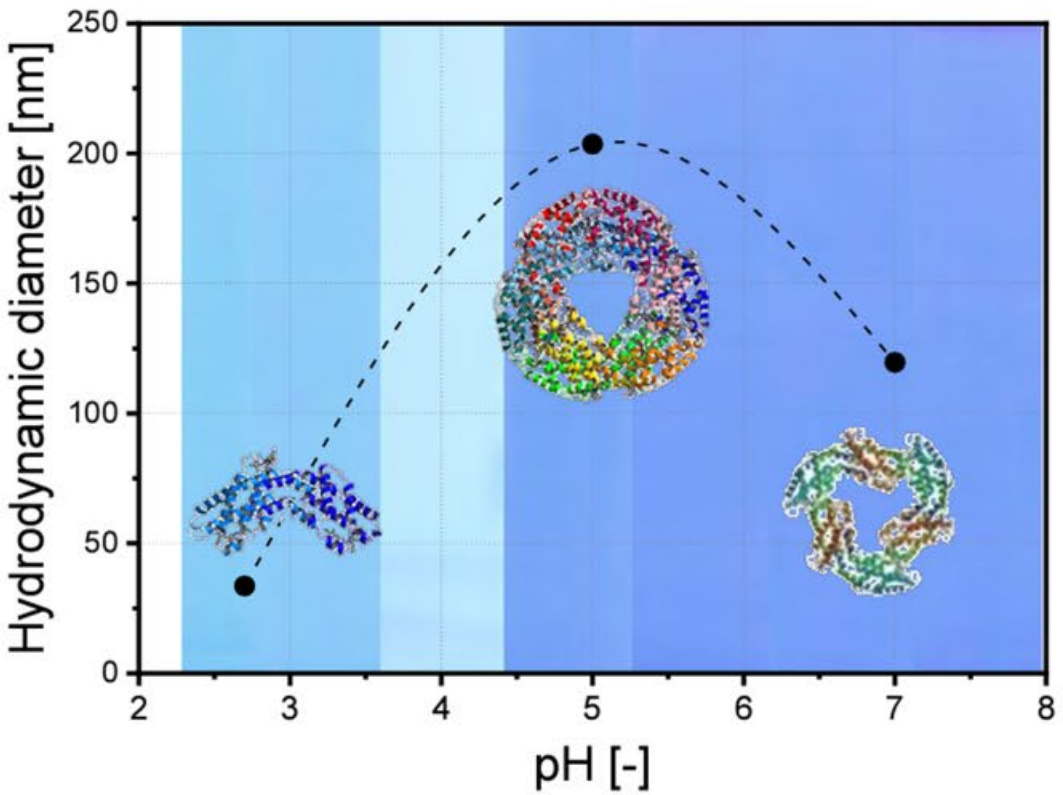




*The common name “Spirulina” refers to the dried biomass of *Arthrospira platensis.*

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:

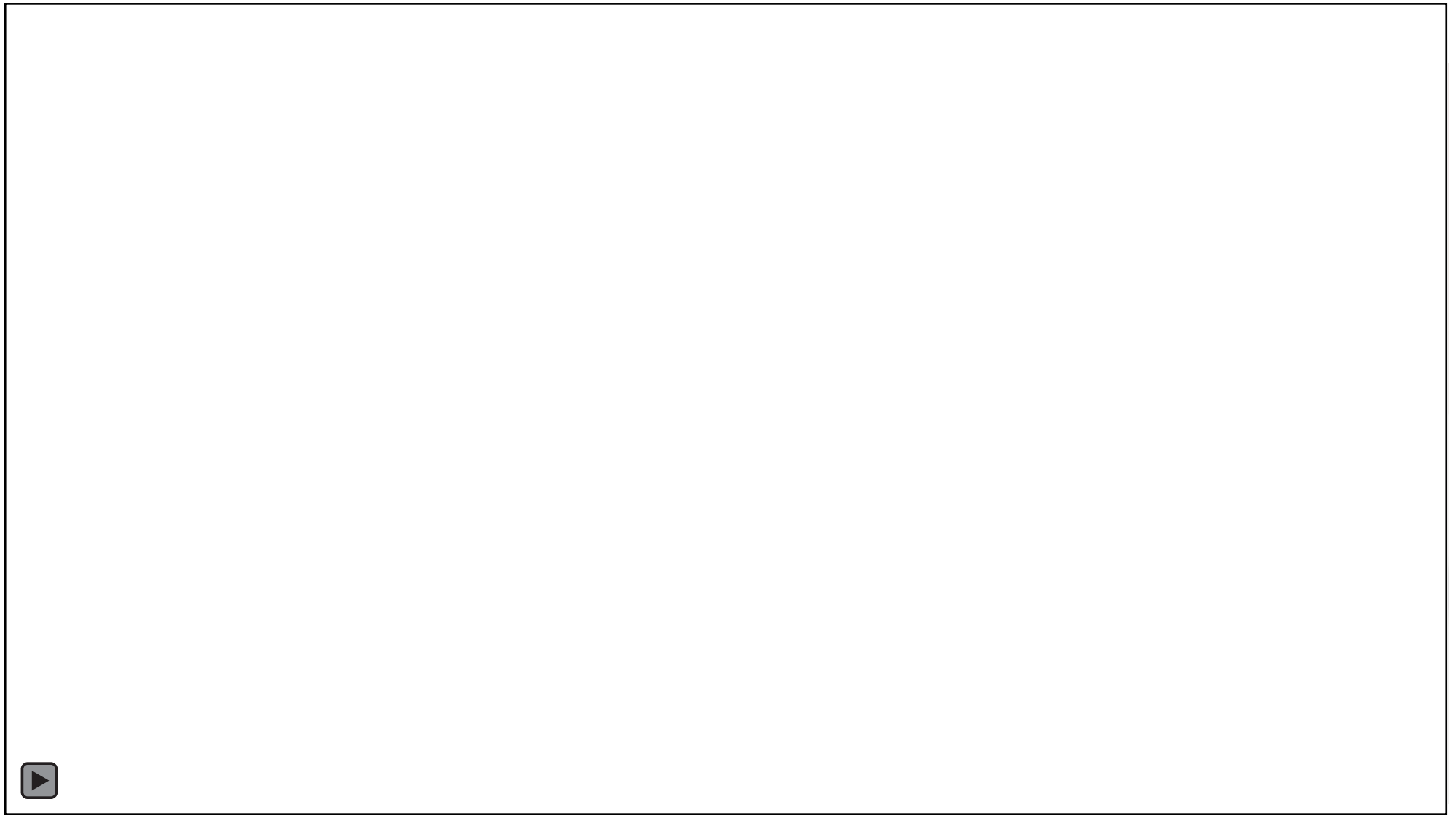
1. Mix 20 drops EXBERRY® Shade Blue - HP with 200 mL invert sugar.
2. Add a full pipette of citric acid solution and stir again.

➢ What do you see?

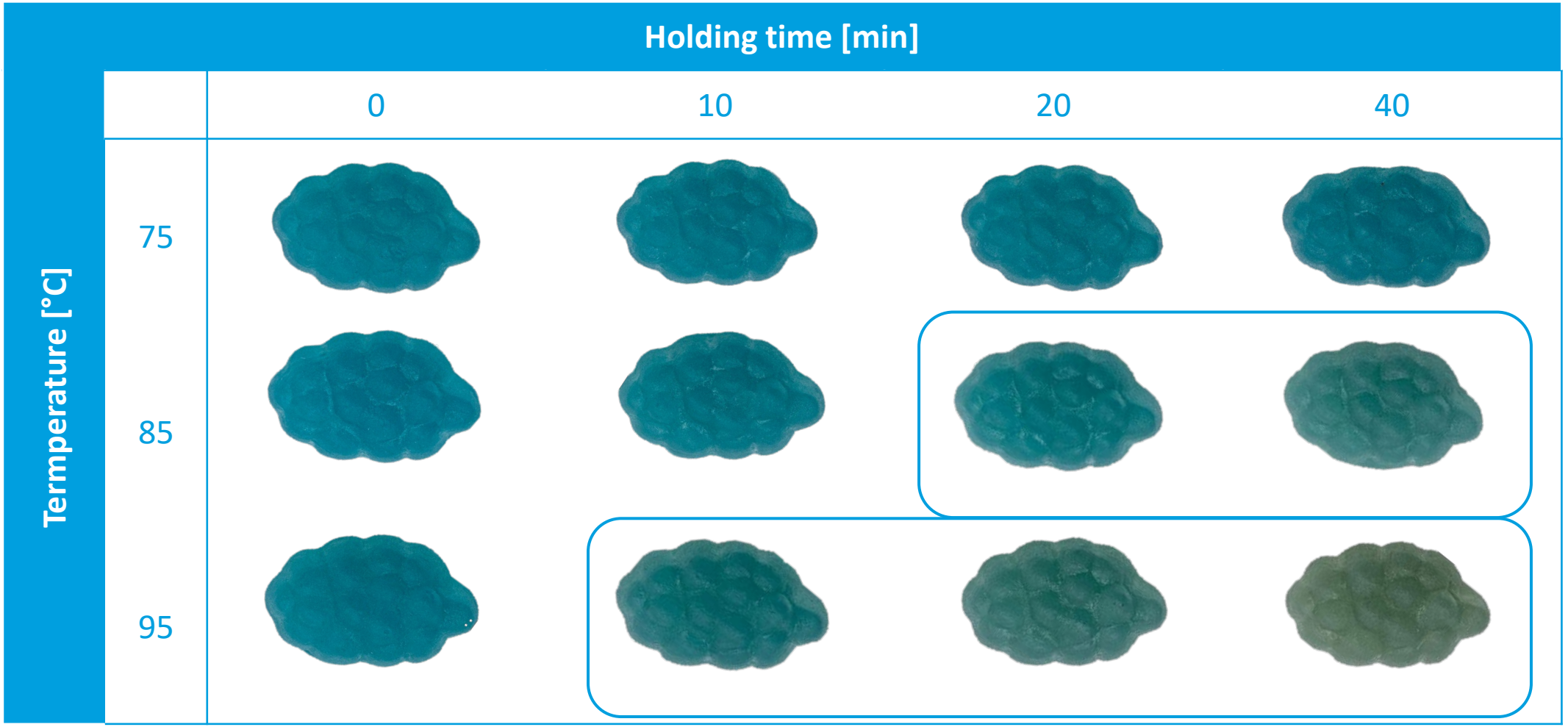
Part 1 Part 2

- 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®



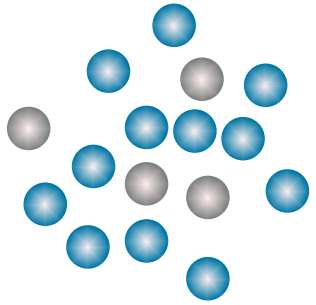
Comparison of holding times at different temperatures in starch gums



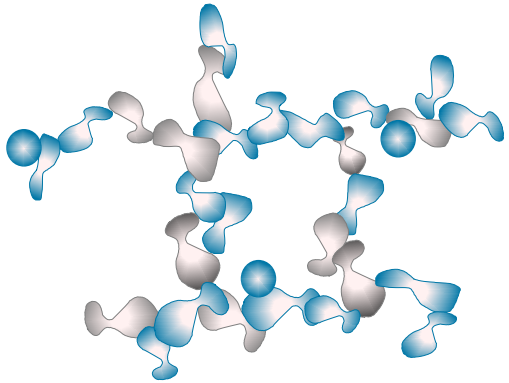
Visible change in color

- 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 ↑



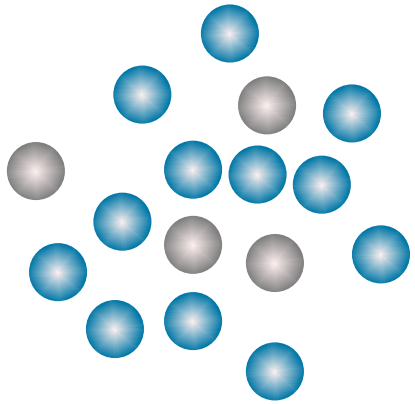
agglomeration

Application temperature = 100 °C

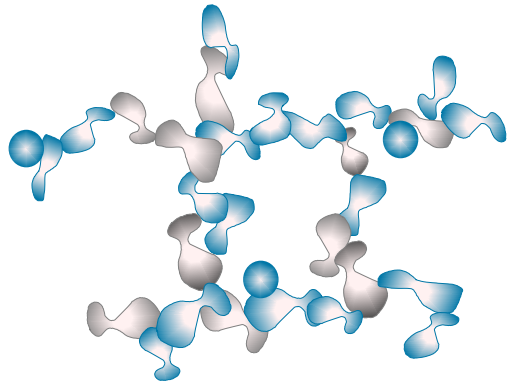
Example: High boiled candies
1.0 % Shade Blue – HP
pH = 6.0 / water content < 2 %

Application temperature = 135 °C

Blue & Green EXBERRY® products – Challenges in application

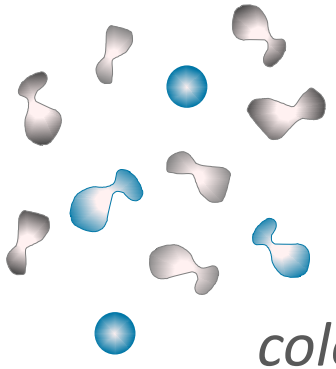


Protein concentration ↑ Temperature ↑



agglomeration

pH ↓ Temperature ↑

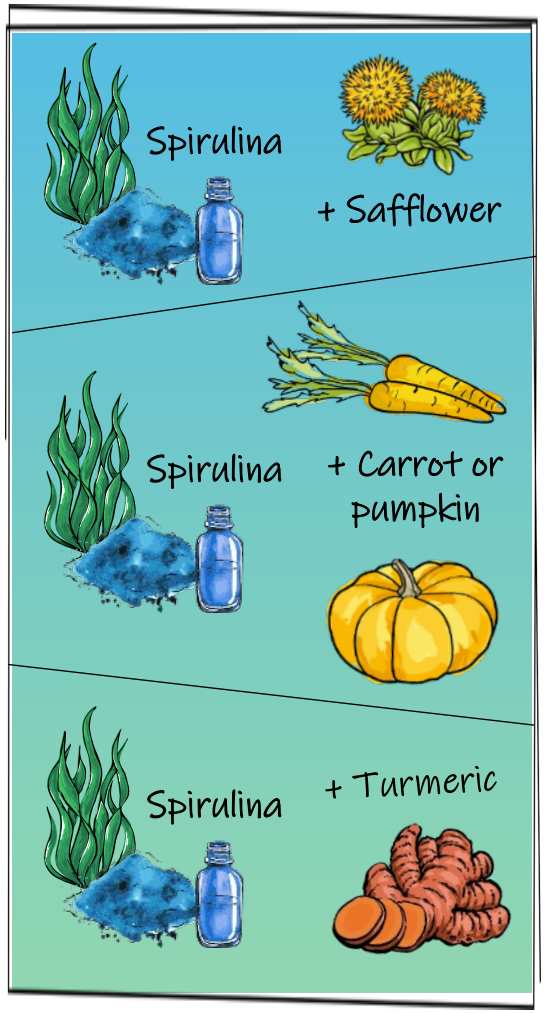


color fading

Color loss *Agglomeration*

Color stability: Blue and green EXBERRY®

Raw materials



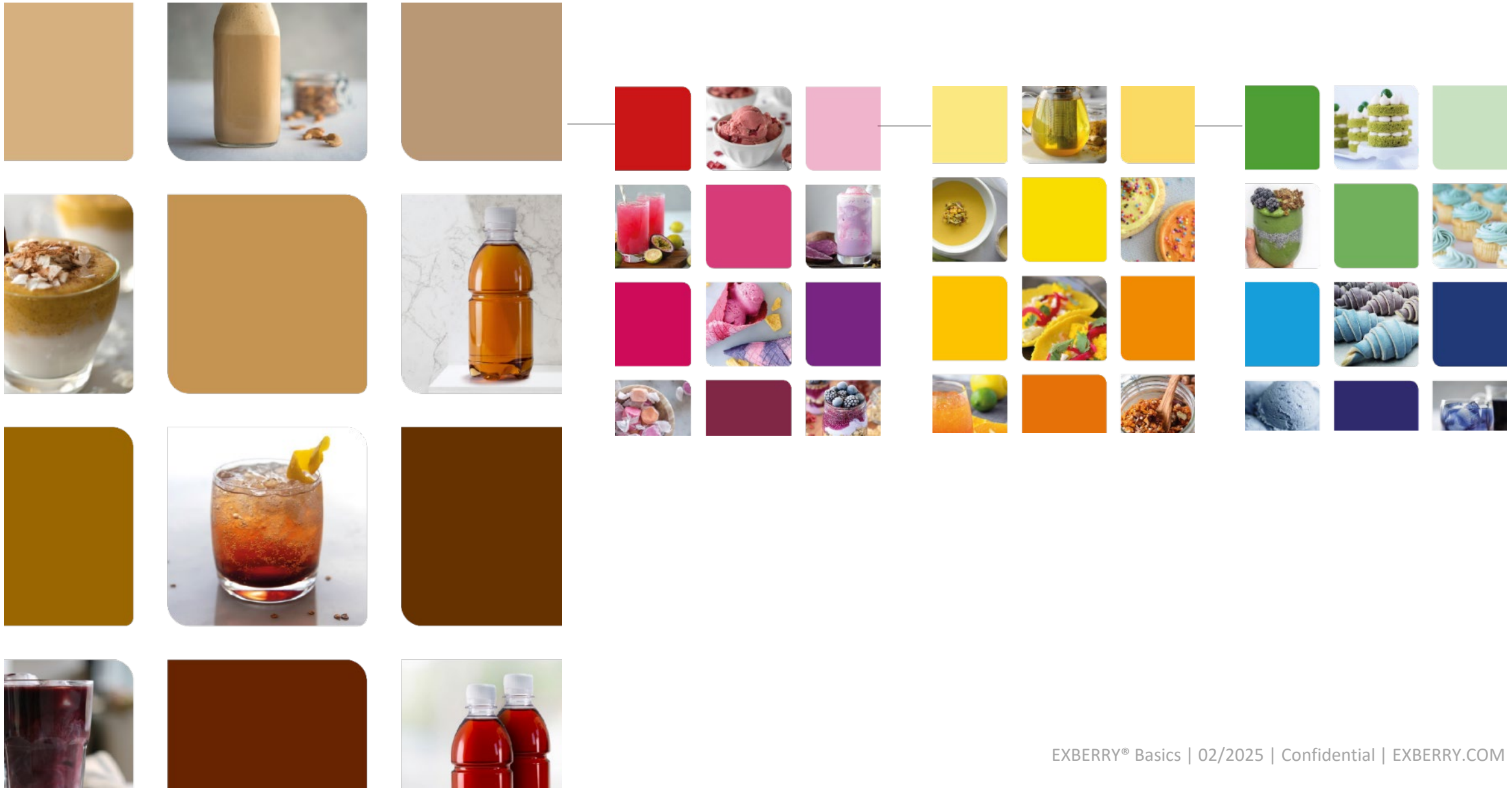
- **Clear** blue or green EXBERRY® made from raw materials containing **phycocyanin** (spirulina) and **safflomin A** (safflower) are:
  - Light stable
  - Heat and acid sensitive

- **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®

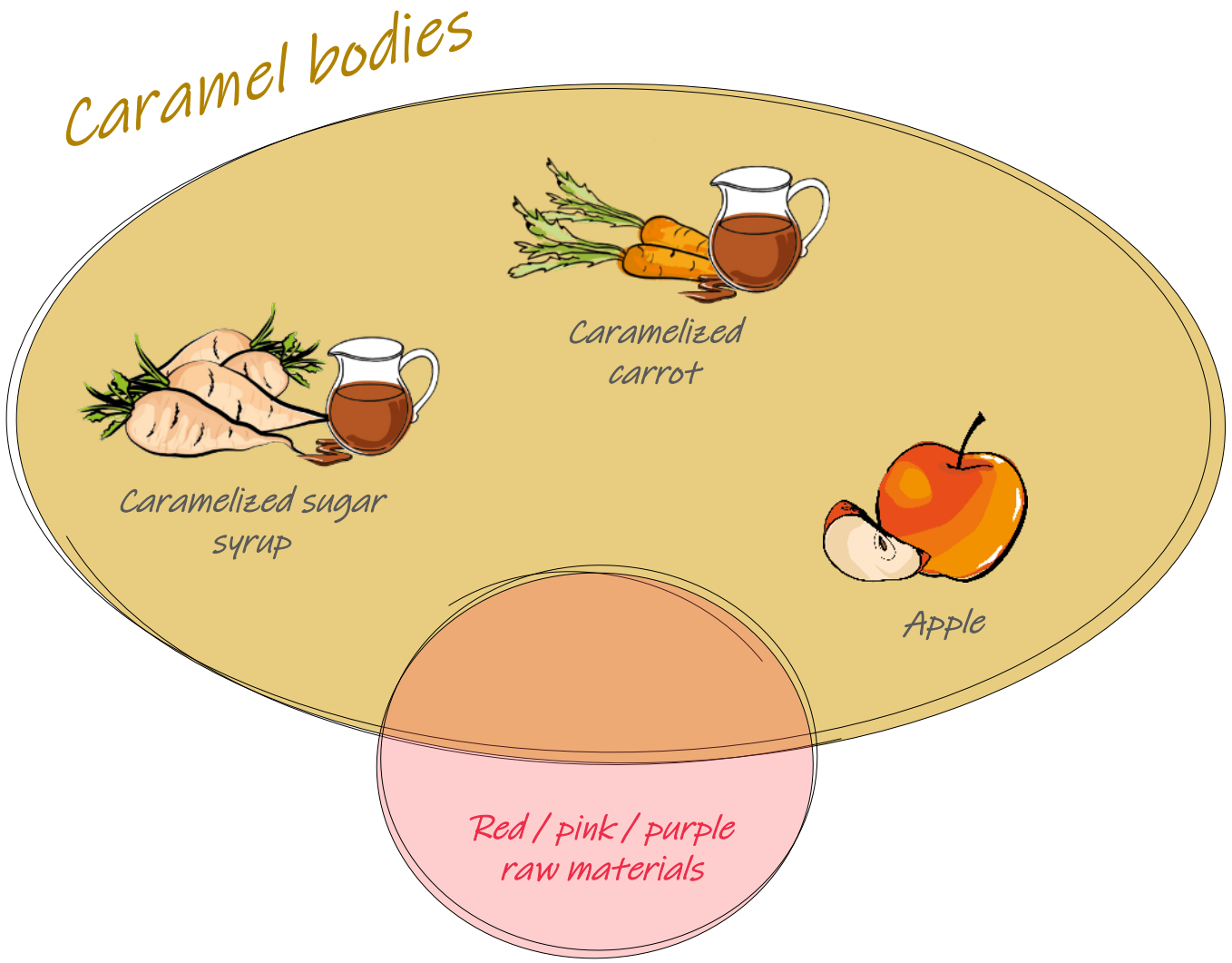
0.31 % EXBERRY®
Shade Russet Brown
(apple)

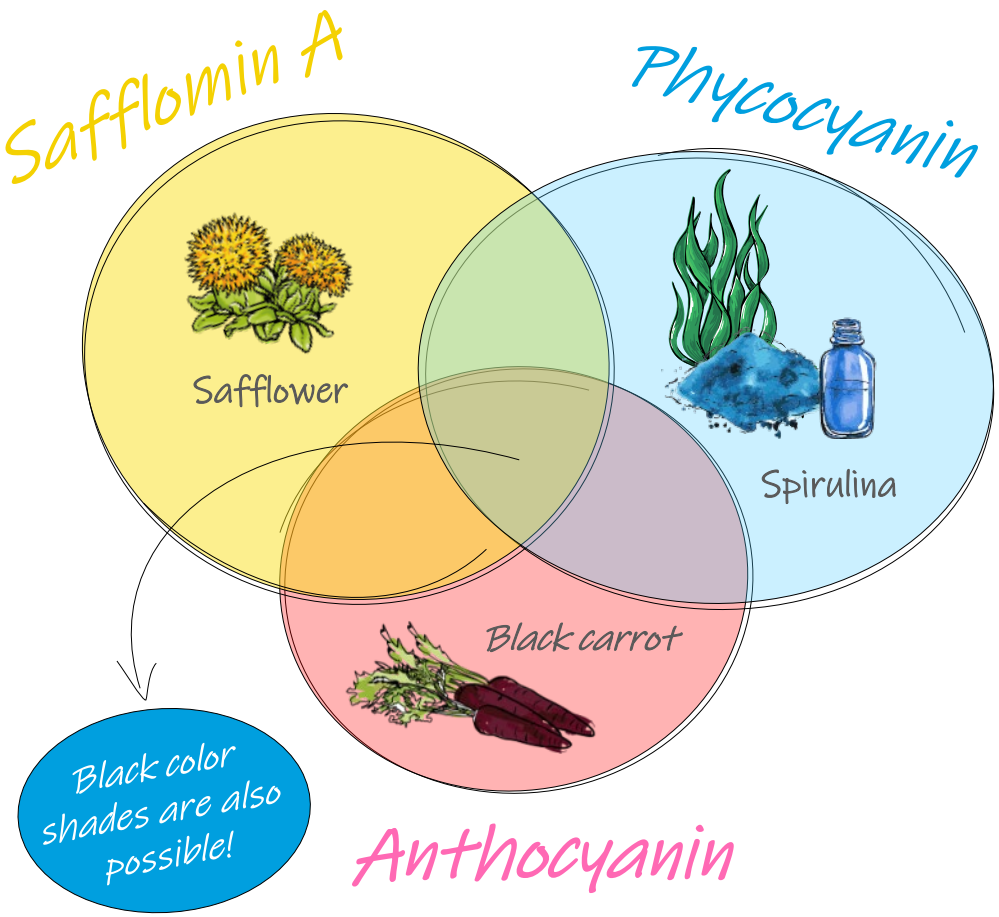
0.20 % EXBERRY®
Shade Brown
(caramelized carrot, carrot)

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)

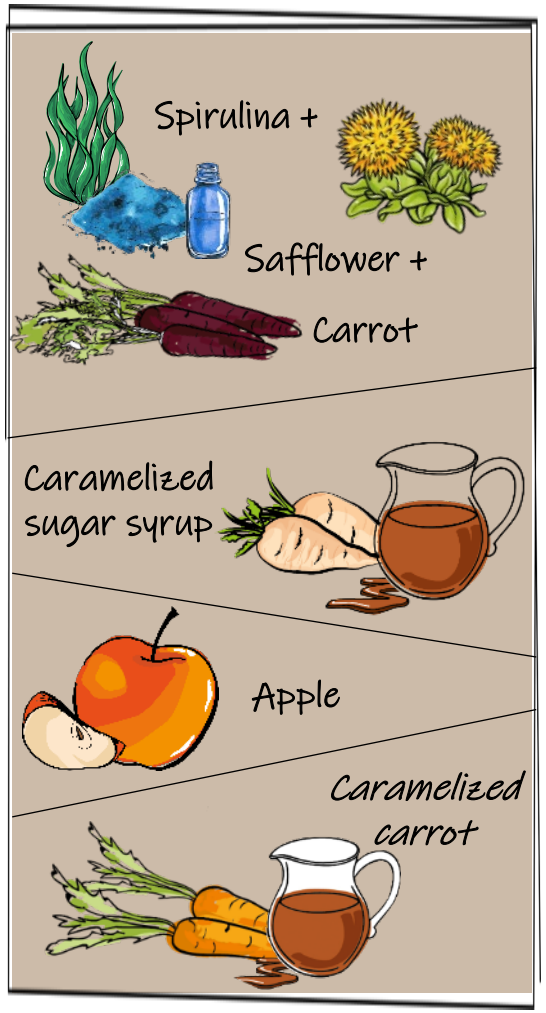
0.09 % EXBERRY®
Shade Autumn Brown
(caramelized sugar syrup, carrot)

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.

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

30% Apple Juice

pH 3.4

pH 3.4

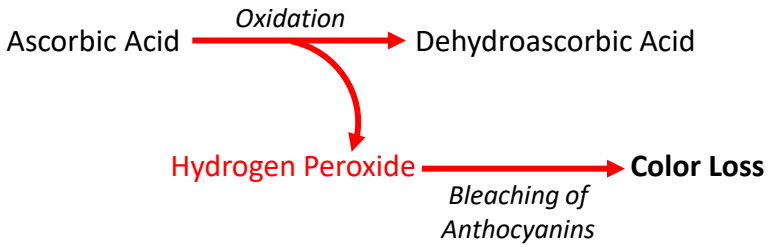
0.05% EXBERRY® Shade Brilliant Pink

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®

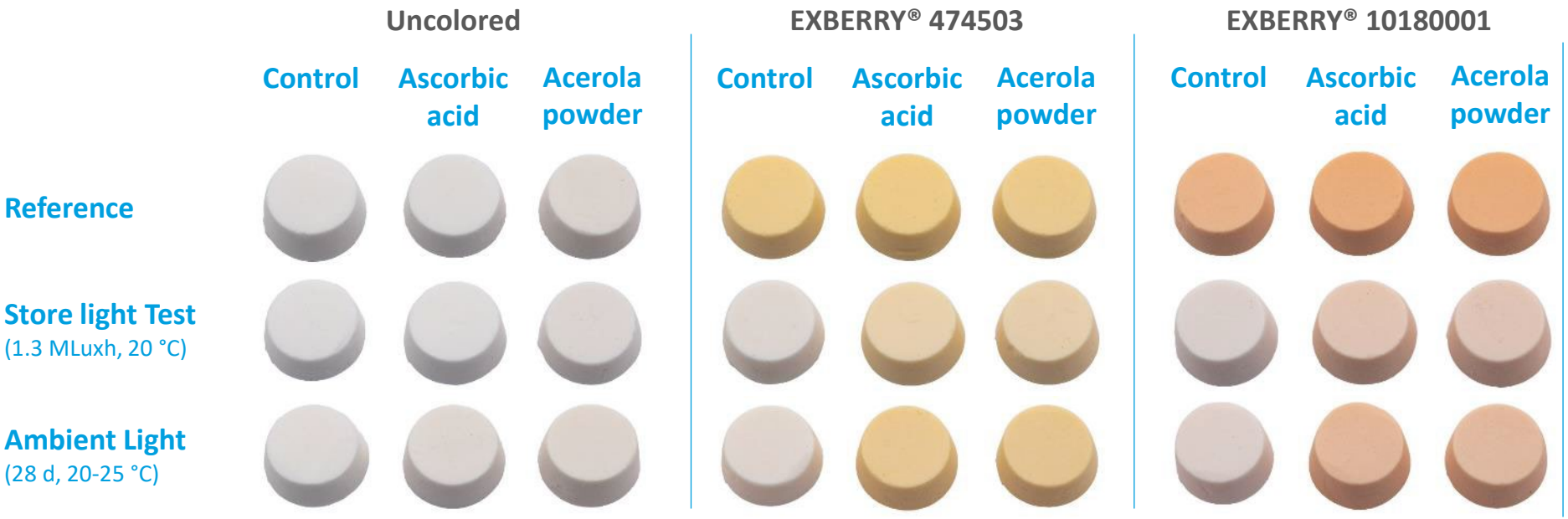
Product parameters: 8° Brix
pH 3.0
Cold preserved

- 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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