Natural Colors & Coloring Food-Stuff in Beer Mixes.
Key parameters for stable colors.

Eric Jouenne
Technical Industry Manager, Beverages - Chr. Hansen A/S
AGENDA

Chr. Hansen A/S

Market and Consumer Trends - Beer Mix & Colors

Which Colors can be used in the EU?

Key parameters (aspect/stability)

Shades & Stability data
Market and Consumer Trends - Beer Mix & Colors

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Shades & Stability data
Chr. Hansen in brief

- Founded in 1874 in Copenhagen by Danish pharmacist Christian D.A. Hansen
- Listed on NASDAQ OMX Copenhagen
- 2012/13 turnover EUR 738 million
- Organic growth ambitions of 7-9% annually
- 2,500 employees
Natural Colors Division

- We develop and produce natural colors for the food industry
- We focus on natural colors in:
  - Beverages
  - Confectionery
  - Ice cream
  - Dairy and fruit preparations
  - Prepared Food
- Our colors originate from natural sources like berries, roots and seeds
- We are global frontrunners in encapsulation and stabilization techniques
## THE WORLD’S NO. 1 IN ALL FOCUS AREAS

<table>
<thead>
<tr>
<th>Category</th>
<th>Market Position</th>
<th>Market Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultures</td>
<td>World No. 1</td>
<td>3-4%</td>
</tr>
<tr>
<td></td>
<td>45%</td>
<td></td>
</tr>
<tr>
<td>Dairy Enzymes</td>
<td>World No. 1</td>
<td>1-2%</td>
</tr>
<tr>
<td></td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>Natural colors</td>
<td>World No.1</td>
<td>5-7%</td>
</tr>
<tr>
<td></td>
<td>16%</td>
<td></td>
</tr>
<tr>
<td>Animal Health &amp; Nutrition</td>
<td>World No.1</td>
<td>+10%</td>
</tr>
<tr>
<td></td>
<td>16%</td>
<td></td>
</tr>
<tr>
<td>Human Health &amp; Nutrition</td>
<td>World No.1</td>
<td>+10%</td>
</tr>
<tr>
<td></td>
<td>20%</td>
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</tbody>
</table>
MARKET AND CONSUMER TRENDS - BEER MIX in EUROPE

- THE MARKET

- Standard lager in 2013 posted a 3% decline in volume sales.

- Beer Mix / Shandy / Radler -> Flavored/mixed lagers is estimated to potentially counter the traditional lager market decline in Europe.

- The European Market is estimated to have a 3% CAGR for flavored/mixed lagers over the period 2014-2018.

- The “mix” category will help to maintain the European volume sales.

Source: Euromonitor International
MARKET AND CONSUMER TRENDS - BEER MIX IN EUROPE

- THE TREND

- Beer and soft drink blends, whether labelled as a beer mixes, shandies or radlers, are becoming increasingly popular in Europe.

- Innovation in this area surged by 21% in 2013.

- Almost all product launched have a sweet taste and low ABV tapping into the growing number of health-conscious consumers limiting alcohol consumption.

- Approx. 30% of launches in Europe YTD 2014 is using Coloring Foodstuff.

Source: Category Insight: Beer - Mintel
MARKET AND CONSUMER TRENDS - BEER MIX IN EUROPE
- THE CONSUMER

Market Research shows:

- 92% of consumers are concerned about synthetic colors.
- 86% of consumers follow news stories about color.
- 88% of consumers believe that natural colors add value.

Source: Consumer Market Research for Food and Beverages done by The Nielsen Company for Chr. Hansen A/S.
Which Colors can be used in the EU?

Key parameters (aspect/stability)

Shades & Stability data
BEER-MIX: WHICH NATURAL COLORS CAN BE USED IN EU?

**Assumption:** Beer-mix classifies as EU food category 14.2.8 *Other alcoholic drinks incl. mixtures of alcoholic drinks with non-alcoholic drinks and spirits with less than 15% alcohol*

<table>
<thead>
<tr>
<th>Permitted - GMP</th>
<th>Permitted - max dosage restrictions (200 mg/l unless others stated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Good manufacturing practices)</td>
<td></td>
</tr>
<tr>
<td>Riboflavin (E 101)</td>
<td>Curcumin (E 100)</td>
</tr>
<tr>
<td>Chlorophylls and Chlorophyllins (E 140)</td>
<td>Carmine, Carminic acid (E 120)</td>
</tr>
<tr>
<td>Copper complexes of chlorophylls/chorophyllins (E 141)</td>
<td>Beta-apo-8’-carotenal (C30) (E160e)</td>
</tr>
<tr>
<td>Caramels (E 150a - E 150d)</td>
<td>Lutein (E 161b)</td>
</tr>
<tr>
<td>Vegetable carbon (E 153)</td>
<td>Quinoline Yellow (E 104) (max 180 mg/l)*</td>
</tr>
<tr>
<td>Carotenes (E 160a)</td>
<td>Sunset Yellow FCF/Orange Yellow S (E 110) (max 100 mg/l)*</td>
</tr>
<tr>
<td>Paprika extract (E 160c)</td>
<td>Amaranth (E 123) (max 30 mg/l)</td>
</tr>
<tr>
<td>Beetroot red (E 162)</td>
<td>Ponceau 4R, Cochineal Red A (E 124) (max 170 mg/l)*</td>
</tr>
<tr>
<td>Anthocyanins (E 163)</td>
<td>Annatto, Bixin, Norbixin (E 160b) (max 10 mg/l)*</td>
</tr>
<tr>
<td>Calcium carbonate (E 170)</td>
<td>Lycopene (E 160d) (30 mg/l)</td>
</tr>
<tr>
<td>Titanium dioxide (E 171)</td>
<td></td>
</tr>
<tr>
<td>Iron oxide and hydroxide (E 172)</td>
<td></td>
</tr>
</tbody>
</table>
| * Only alcoholic drinks with less than 15% of alcohol

**Coloring Foodstuff**
- can be used in this category without restrictions -

NATURAL COLOURS - MAIN SOURCES

- Chlorophyllin
- Turmeric
- Lutein
- Carotenes
- Natural Beta Carotene
- Beta Carotene
- Annatto
- Paprika
- Carmine
- Red Beet
- Anthocyanins
- Caramel
- Carbo Vegetabilis
FRUITMAX® - COLOURING FOOD STUFF
MAIN SOURCES

- Carthamus
- Pumpkin
- Yellow Carrot
- Orange Carrot
- Red Beet
- Hibiscus
- Elderberry
- Aronia
- Blackcarrot
- Grape juices
- Burnt Sugars
- Malt Extract
COLORING FOODSTUFF PREPARATION
No selective extraction, Fn < 6

Primary concentrate/extract

Covered by EU CFS Guidance Notes

Covered by general EU food law and additives regulations

Additives

E.g.: Citric acid (E330) or α-Tocopherol (E307) = Group 1 additives

Ingredients without E-no like sugar, oil

E.g.: Invert sugar or oils

FruitMax preparation

Add Date and Footer via >Insert >Header & Footer
1. Check in Date & Time
2. Check in Footer
4. Fill in text field
5. Click 'Apply to All'
Natural Colors, Coloring Food-Stuff in Beer Mixes.

Technical insights
Chr. Hansen A/S

Market and Consumer Trends - Beer Mix & Colors

Which Colors can be used in the EU?

Key parameters (aspect/stability)

Shades & Stability data
IMPACT OF DOSAGE

Background changes the overall aspect
Always test in the final recipe
Increase dosage improves shade intensity, brightness and deepness
Increase dosage will drastically improve the stability to light
Colour shift may occur with dosage

ColorFruit® Violet 100 WS (vegetable source)

<table>
<thead>
<tr>
<th>Dosage</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 g/L</td>
<td>Light</td>
</tr>
<tr>
<td>0.4 g/L</td>
<td>Medium</td>
</tr>
<tr>
<td>0.6 g/L</td>
<td>Dark</td>
</tr>
</tbody>
</table>

DARKER & BETTER STABILITY
IMPACT OF PACKAGING SIZE

ColorFruit® Violet 100 WS (vegetable source)

<table>
<thead>
<tr>
<th>PACKAGING SIZE</th>
<th>KEY FACTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4 g/L</td>
<td>- Size &amp; volumes will change the color aspect.</td>
</tr>
<tr>
<td>200 mL</td>
<td>- Color shift may occur with dosage</td>
</tr>
<tr>
<td>330 mL</td>
<td>- In large packaging, shade will be darker and deeper</td>
</tr>
<tr>
<td>500 mL</td>
<td>- In small packaging and in bottle neck, shade will be much paler</td>
</tr>
<tr>
<td></td>
<td>- Stability to light is better in larger size</td>
</tr>
</tbody>
</table>

DARKER & BETTER STABILITY
IMPACT OF pH - CRITICAL FOR ANTHOCYANINS

FruitMax® Cranberry WS (blackcarrot) 0.6g/L

<table>
<thead>
<tr>
<th>USUAL pH RANGE</th>
<th>KEY FACTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH 2.8</td>
<td>• Carotenoids, carthamus, chlorophylls,..are not sensitive to pH</td>
</tr>
<tr>
<td>pH 3.2</td>
<td>• Anthocyanins ARE SENSITIVE</td>
</tr>
<tr>
<td>pH 3.7</td>
<td>• More bluish shade with pH increase</td>
</tr>
<tr>
<td>pH 5</td>
<td>• Lower stability to light</td>
</tr>
<tr>
<td></td>
<td>• Poor stability above pH 5</td>
</tr>
<tr>
<td></td>
<td>• Decrease pH for better stability</td>
</tr>
</tbody>
</table>

COLOR SHIFTING & LOWER STABILITY
### IMPACT OF MINERALS ex. Fe\(^{2+}\)

**FruitMax® Cranberry WS (blackcarrot) 0.6g/L**

<table>
<thead>
<tr>
<th>After 14 days exposed to Light</th>
<th>KEY FACTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>No Fe(^{2+})</td>
</tr>
<tr>
<td></td>
<td>0.05 mg/L Fe(^{2+})</td>
</tr>
<tr>
<td></td>
<td>0.15 mg/L Fe(^{2+})</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
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<td></td>
</tr>
</tbody>
</table>

**LOWER STABILITY & BROWNING**
IMPACT OF SUGARS

FruitMax® Cranberry WS (blackcarrot) 0.6g/L

After 14 days exposed to Light

T0  Sucrose  Fructose

KEY FACTS

- Colour preparation could be sensitive to bulk sugars
- Fructose-rich matrices use to be more aggressive for colours
- In 100% fructose recipe, we may see more browning effect
- To adjust sugars ratio
- To control when changing recipe

LOWER STABILITY
IMPACT OF DISSOLVED OXYGEN - $O_2$

**ColorFruit® Yellow 400 WSS** (carotene emulsion) 0.075g/L

**After 14 days exposed to Light**

- **T0**
- + 100mg/L AA
- No AA

**KEY FACTS**

- Carotenoids, chlorophylls are sensitive to oxidation (photo)
- 100ppm of added ascorbic acid is recommended in sparkling drink
- Ascorbic acid is detrimental for anthocyanins, leading to fading and browning effect
- **Control dissolved oxygen**
- **Balance ascorbic acid added**
HOW CAN WE GUARANTEE NATURAL COLORS WITHOUT NATURAL MICROBIAL CONTAMINANTS?

- All natural raw materials contain natural microorganisms associated with their natural environment.
- Several of these can give problems in natural colors beer-mixes
- A multi-faceted approach is applied to mitigate the risk

Mixes before mixing with beer

Characteristics
- Low pH, nutrients,

Microbial challenges
- Molds: mycotoxins, off flavors, gushing
- Yeast: fermentation, off flavors, haze
- TAB: off flavors (guaiacol)
- LAB: fermentation, off flavor, haze

Finished beer mix products

Characteristics
- Low pH, nutrients, alcohol, CO₂,

Microbial challenges
- Molds: no growth (require oxygen)
- Yeast: fermentation, off flavors, haze
- TAB: no growth (require oxygen)
- LAB: fermentation, off flavor, haze
MULTI FACETED APPROACH TO FIGHT THE MICROBIOLOGICAL TREATMENT

- High quality raw materials
- Hygienic design: We use European Hygienic Engineering Design Group, EHEDG guidelines to ensure that the equipment can actually be cleaned and sanitized.
- GMP and HACCP - to control, monitor and document procedures to avoid growth
- Limit production time with high temperatures (>30°C) where TAB can grow
- Pasteurization - kills molds, yeasts and LAB
- Stronger heat can be applied as UHTST Ultra High Temperature Short Time to eliminate TAB
- Microbial analysis of finished products before release to customer.
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Shades & Stability data

SHADES OPTIONS TO ILLUSTRATE
GOOD PERFORMING OPTIONS

- Colouring food-stuffs for beer mixes: FruitMax®
- Natural colours for beer mixes: ColorFruit®, Vegex™

ColorFruit® Violet 100 WS
FruitMax® Plum WS
FruitMax® Cranberry WS
FruitMax® Elderberry WS
ColorFruit® Red 160WS
Vegex™ Tangerine 520 WS
FruitMax® StarFruit Bright WS
ColorFruit® Yellow 400 WS
FruitMax® Brown WS
ColorFruit® Green 801 WS
Which Colors can be used in the EU?

REAL STABILITY DATA
LIGHT/WARM CONDITIONS

Shades & Stability data
TESTING CONDITIONS

**RECIPE**

- **BEER MIX:**
  - 2.5% alc. (volume)
  - 7.4 °Brix
  - pH: 3.2

- **INGREDIENTS:**
  - Water
  - Pale lager Beer
  - Glucose syrup
  - Fructose
  - Saccharose
  - Citric acid
  - Preservatives
  - Ascorbic Acid (if needed)

**AGEING TESTS**

- **LIGHT EXPOSURE**
  - Artificial light
  - Solar spectrum
  - 14 days / 23 °C
  - 1600 Langley

- **WARM STORAGE**
  - 40 °C in Binder Oven
  - Humidity 60%

**COLOR READINGS**

- DE values, DATACOLOR 650
  - DE < 3 is excellent
  - DE < 6 is very good
  - DE < 10 is acceptable
Which Colors can be used in the EU?

OPTIONS WITH GOOD STABILITY

Shades & Stability data
ColorFruit® Yellow 400 WSS
Natural Beta Carotene

- Dosage: 0.075 g/L
- Ascorbic acid: 250ppm

<table>
<thead>
<tr>
<th></th>
<th>T0</th>
<th>40 °C Light</th>
<th>After 7 days</th>
<th>40 °C Light</th>
<th>After 14 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>De 2000 Ref.</td>
<td></td>
<td></td>
<td>7.1</td>
<td>3.1</td>
<td>9.0</td>
</tr>
</tbody>
</table>

- Bright shades
- Robust to light exposure
- Good stability to warm storage

CHR HANSEN
Improving food & health
FruitMax® Elderberry WS
Black Carrot Concentrate

- Dosage: 0.6 g/L
- Ascorbic acid: no

<table>
<thead>
<tr>
<th>De 2000</th>
<th>Ref.</th>
<th>2.5</th>
<th>5.7</th>
<th>4.0</th>
<th>9.2</th>
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</thead>
<tbody>
<tr>
<td>After 7 days</td>
<td>Light</td>
<td>40°C</td>
<td>Light</td>
<td>40°C</td>
<td>Light</td>
</tr>
</tbody>
</table>
- Bright red shade
- Fairly good stability to light
- A bit fading and browning
- Good stability to warm storage
FruitMax® Cranberry WS
Black Carrot Concentrate

- Dosage: 0.6 g/L
- Ascorbic acid: no

<table>
<thead>
<tr>
<th>T0</th>
<th>After 7 days</th>
<th>After 14 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 °C Light</td>
<td>40 °C Light</td>
<td></td>
</tr>
</tbody>
</table>

- Bright red shade
- Good stability to light
- Good stability to warm storage
- Limited browning effect
FruitMax® Plum WS
Black Carrot Concentrate

- Dosage: 0.4 g/L
- Ascorbic acid: no

<table>
<thead>
<tr>
<th>De 2000</th>
<th>Ref.</th>
<th>After 7 days</th>
<th>After 14 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>40 °C</td>
<td>Light</td>
<td>Light</td>
</tr>
</tbody>
</table>

- Bright red-violet shade
- Very good stability to light
- Very good stability to warm storage
- Limited browning effect
Market and Consumer Trends - Beer Mix & Colors

Which Colors can be used in the EU?

OPTIONS WITH SUPERIOR STABILITY

Shades & Stability data
FruitMax® StarFruit Bright WS Safflower Concentrate

- Dosage: 0.3 g/L

- Ascorbic acid: no

<p>| | | |</p>
<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>De 2000</td>
<td>Ref.</td>
<td>0.8</td>
</tr>
<tr>
<td>T0</td>
<td>40 °C</td>
<td>Light</td>
</tr>
<tr>
<td>After 7 days</td>
<td>40 °C</td>
<td>Light</td>
</tr>
<tr>
<td>After 14 days</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Transparent bright yellow shade
- Need significant dosage to cover colour background
- Very good stability to light
- Excellent stability in warm conditions
Vegex™ Tangerine 520 WS
Carminic Acid

• Dosage: 0.2 g/L

• Ascorbic acid: no

- Very bright transparent orange shade
- Excellent stability to light and warm storage
- Best performing pigment
- Optimal stability at medium dosage to cover matrix background
ColorFruit® Red 160 WS
Anthocyanins - Ultra Stable Red™

- Dosage: 0.5 g/L
- Ascorbic acid: no

![Image of ColorFruit® Red 160 WS]

After 7 days
- 40°C Light
- De 2000: 2.3
- Ref.: 2.9
- After 14 days
- 40°C Light
- De 2000: 3.4
- Ref.: 5.0

- Bright red shade - equivalent to elderberry
- Excellent stability to light and warm storage
- BEST PERFORMING ANTHOCYANINS
- 30% better than blackcarrot
KEY POINTS

Sum-up

- GOOD MARKET GROWTH IN BEER MIXES OVER THE PAST YEARS
- COLOURING FOOD-STUFFS ARE PERMITTED WITH NO RESTRICTIONS IN BEER-MIXES
- MOST NATURAL COLORS ARE PERMITTED FOR COLORING BEER MIXES
- GREAT OPTIONS FOR GETTING STABLE AND BRIGHT NATURAL COLORS
- CHR. HANSEN PROVIDES THE FULL PALLETTE OF NATURAL COLORS AND COLORING FOODSTUFF FOR THE BEER MIX MARKET