Colour Measurement in Beer-mix Beverages as a Success Factor of a Multi-Sensory Experience

Jean Titze, Christine Thomas, Yvonne Pohl, Olaf Biedekarken, Edward Norder

Multi-Sensory Experience
Perception of colours
Colour measurement
Multi-Sensory Experience

Perception of colours

Colour measurement
Colour measurement in beer-mix beverages
The house of Multi-Sensory Experience

Natural and brilliant colours
Hazyness or crystal clear

Carbonation
Crackling
Clicking
...

Sound

DÖHLER Multi-Sensory Experience

Texture

Purees
Inclusions (bubbles)
Emulsions
Natural texturizer

Flavours
Sweetening solutions
Cooling sensation
...

Taste

Odour/Smell

Flavours
Freshness
Authenticity
...

Look
Colour measurement in beer-mix beverages
Multi-Sensory Experience: addressing all senses

Successful products address various senses in a positive way and stimulate and create a deep emotional involvement of the consumer:

Döhler Multi-Sensory Experience
Colour measurement in beer-mix beverages
Why is Multi-Sensory Experience important?

How do you rate this beverage overall?

<table>
<thead>
<tr>
<th>very poor</th>
<th>indifferent</th>
<th>very good</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

What is the taste of this beverage?

Identical taste (orange flavour) but different colours!
Colour measurement in beer-mix beverages
Sensory acceptance - results ($n = 141$)
**Colour measurement in beer-mix beverages**

Taste - results \( (n = 141) \)

- **orange, tangerine**
  - Product 1: 16%
  - Product 2: 58%

- **apple, woodruff**
  - Product 1: 12%
  - Product 2: 36%
Can the **look** of a beverage influence the impression of the actual consumer trend of **naturalness**?

- **Natural and brilliant colours**
- **Hazyness or crystal clear**

**Look**  
**Naturalness**  
**Healthier lifestyle**  
**“Clean label”**
Colour measurement in beer-mix beverages
Set-up of survey

Total participants
\[ n = 178 \]

Sample size after the first filter question
(Consumption of beverages)
\[ n = 161 \]

Sample size after the second filter question
(Relevance of colour)
\[ n = 139 \]

Sample size after the third filter question
(Relevance of naturalness)
\[ n = 130 \]

Filter questions:

How often are you buying beverages?

What parameter is influencing your decision, when you buy a beverage for the first time?

Is the characteristic of naturalness important for you?
Colour measurement in beer-mix beverages
What parameter is influencing your buying decision (initial purchase)?

- Colour
  - 4% not important
  - 2% neither nor
  - 5% very important
  - 2% neither nor
  - 17% very important
  - 16% neither nor
  - 16% very important
  - 28% neither nor
  - 18% very important
  - 7% neither nor

- Price
  - 6% not important
  - 1% neither nor
  - 9% very important
  - 9% neither nor
  - 30% very important
  - 26% neither nor
  - 20% very important

- Packaging
  - 6% not important
  - 1% neither nor
  - 7% very important
  - 2% neither nor
  - 11% very important
  - 24% neither nor
  - 25% very important
  - 17% neither nor
  - 6% very important

- Origin
  - 5% not important
  - 6% neither nor
  - 5% very important
  - 7% neither nor
  - 16% very important
  - 12% neither nor
  - 16% very important
  - 21% neither nor
  - 11% very important

- Brand
  - 10% not important
  - 7% neither nor
  - 7% very important
  - 7% neither nor
  - 16% very important
  - 14% neither nor
  - 16% very important
  - 15% neither nor
  - 7% very important
Colour measurement in beer-mix beverages
Is the characteristic of naturalness important for you?

$n=130$

Naturalness

- not important
- neither nor
- very important

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Colour measurement in beer-mix beverages
How natural are these beverage categories?

Soft drinks
- Not important: 22%
- Neither nor: 16%
- Very important: 21%
- 14%
- 12%
- 8%
- 2%

Juices
- Not important: 2%
- Neither nor: 7%
- Very important: 18%
- 37%
- 35%

Spritzers
- Not important: 3%
- Neither nor: 8%
- Very important: 25%
- 38%
- 25%

Smoothies
- Not important: 2%
- Neither nor: 5%
- Very important: 6%
- 12%
- 24%

Near water
- Not important: 7%
- Neither nor: 6%
- Very important: 15%
- 12%
- 21%
- 5%

Sport drinks
- Not important: 15%
- Neither nor: 16%
- Very important: 21%
- 15%
- 18%
- 7%
- 5%
- 4%

Energy drinks
- Not important: 11%
- Neither nor: 5%
- Very important: 51%
- 18%
- 10%
- 6%
- 8%
- 4%

Alcoholic beverages
- Not important: 11%
- Neither nor: 5%
- Very important: 5%
- 26%
- 16%
- 15%
- 10%
- 5%
Colour measurement in beer-mix beverages
How important is the aspect of “naturalness” in these categories?

<table>
<thead>
<tr>
<th>Category</th>
<th>not important</th>
<th>neither nor</th>
<th>very important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft drinks</td>
<td>4%</td>
<td>5%</td>
<td>9%</td>
</tr>
<tr>
<td>Juices</td>
<td>3%</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>Spritzers</td>
<td>8%</td>
<td>5%</td>
<td>6%</td>
</tr>
<tr>
<td>Smoothies</td>
<td>22%</td>
<td>8%</td>
<td>11%</td>
</tr>
<tr>
<td>Near water</td>
<td>2%</td>
<td>1%</td>
<td>4%</td>
</tr>
<tr>
<td>Sport drinks</td>
<td>8%</td>
<td>2%</td>
<td>5%</td>
</tr>
<tr>
<td>Energy drinks</td>
<td>5%</td>
<td>20%</td>
<td>75%</td>
</tr>
<tr>
<td>Alcoholic beverages</td>
<td>3%</td>
<td>8%</td>
<td>28%</td>
</tr>
</tbody>
</table>

Colour measurement in beer-mix beverages shows the importance of the aspect of “naturalness” in different categories. The data is represented in a bar chart with three categories: not important, neither nor, and very important.
Beverages perceived as natural should...

...show a significant colour intensity.

...have a stable turbidity.

...be corresponded by the matching flavour to the colour.
Colour measurement in beer-mix beverages
Conclusion of the survey 2/2

Colour influences the consumers perception of ...

Naturalness
“Cloud is natural”

Flavour
“Colour indicates taste”

Sweetness
“More intense more sweet”

**Buying Decisions**
Therefore, the colour is one of the most important components to be considered in product development and marketing!
Multi-Sensory Experience

Perception of colours

Colour measurement

References & presenters
The perception of colours is based on visible light. A triangular prism is used to disperse visible light, that is, to break light up into its spectral components (the colours of the rainbow).

This means that different wavelengths of light will travel at different speeds. So, the light will disperse into the colours of the visible spectrum, with longer wavelengths (red, yellow) being less refracted than shorter wavelengths (violet, blue).

Source: www.u-helmich.de
Colour measurement in beer-mix beverages
Absorption (complementary colour) 1/2

Due to the refraction index of glass for the different wavelengths, white light is divided up into its colour spectrum by a prism.

With a second prism which works in the same way, the colour spectrum can be transferred into white light again.

If a distinct part of the colour spectrum is absorbed, e.g. the blue one, before it reaches the second prism, the resulting light appears yellow instead of white.

Therefore, white light minus blue light equals yellow light. In general, one speaks of complementary colour.
When white light hits a green leaf the electrons of the chlorophyll molecules in the chloroplast are mainly excited by the red light. The red light is hence absorbed by the chlorophyll. Therefore, the light reflected by the leaf does not contain any red and the human eye sees the leaf as green.
The absorption spectrum of natural chlorophyll extract: The extract absorbs mainly blue and red light.

The colour of the natural chlorophyll extract is a mixture of both complementary colours yellow and green.

Source: www.u-helmich.de
Colour measurement
Perception of colours
Multi-Sensory Experience
References & presenters
Colour measurement in beer-mix beverages

Agenda

- What contributes to appearance?
- How is colour measured currently?
- Limitations in beer and beer-mix beverages
- Why do we quantify the appearance of beer-mix beverages?
- Alternative method: Colorimetry
- Comparison of different methods
Colour measurement in beer-mix beverages
What contributes to appearance?

**Reflection**
- Defines surface gloss

**Absorption**
- Defines colour

**Transmission**
- Defines turbidity

Cyanidin-3-Glycoside

[Graph showing number density against turbidity]
Colour measurement in beer-mix beverages
How is colour measured currently?

1. Beer:
   EBC or SRM
   a) Visual Comparison
      (Lovibond Comparator, BJCP Colour Guide)
   b) Photometry
      (Spectrophotometer)

2. Brown Colours:
   EBC_{610\,nm} (Caramel Colours),
   EBC_{430\,nm} (Colour Malt Extracts),
   E_{420\,nm} (Burnt Sugar)

\[ E_{430\,nm} = E_{430\,nm,0.1\%} \cdot 25 \cdot DF \]
\[ SRM(ASBC) = E_{430\,nm} \cdot 12.7 \cdot DF \]
\[ E_{530\,nm}(IoB) = E_{530\,nm,0.1\%} \cdot 1000 \cdot DF \]
\[ E_{610\,nm}(JECFA) = \frac{E_{610\,nm,0.1\%} \cdot 20,000}{F} \]
\[ Tinctorial\ Power = \frac{E_{560\,nm,0.1\%} \cdot 100}{DM} \]
\[ Colour\ Intensity(JECFA) = \frac{E_{610\,nm,0.1\%} \cdot 100}{DM} \]

DF: dilution factor
F: factor, e.g. 0.104 (for double strength E150d)
DM: dry matter
Colour measurement in beer-mix beverages
Limitations in beer and beer-mix beverages

**Beer:**
- Value depends on observer (Visual)
- Differences between methods (Visual vs. Photometric)
- Steep curve at 430 nm leads to mistakes
- Differences between light and diluted dark beers
- Colour hue not accounted for
- Perception of turbidity and colour as one, but separate analysis

**Beer-mix beverages:**
- Added colourant changes absorption spectrum
- Matching with photometric data not accurate
- Reactions might occur, stability needs to be monitored
Colour measurement in beer-mix beverages
Why do we quantify the appearance of beer-mix beverages?

External factors
- Light
- Oxygen
- Heat
- Long shelf life

Internal factors
- Proteins
- Polyphenols
- Other colourants
- Antioxidants

Product changes
- Browning
- Colour fading
- Ringing
- Sedimentation
- Turbidity increase

Fading of Colour Malt Extract

Browning of Anthocyanin Extract
Colour measurement in beer-mix beverages
Alternative method: Colorimetry

- Standardized light D65 or C (daylight)
- Standardized angle of observer 10°
- Light is scattered by Ulbricht sphere
- Measurement in transmission or reflection
- Analysis using normalized sensitivity curves
- Tristimulus values XYZ are transformed into the uniform L*a*b* space
- Euclidean distance is equivalent to perceived colour distance:

\[
\Delta E = \sqrt{(L^* - L_{\text{ref}}^*)^2 + (a^* - a_{\text{ref}}^*)^2 + (b^* - b_{\text{ref}}^*)^2}
\]

- C*(Chroma) and h° (Hue) are the polar coordinates of the a*b* plane

Normalized sensitivity curves of the Standard Observer (defined by CIE in 1931) for X (red), Y (green), Z (blue)
## Colour measurement in beer-mix beverages
Comparison of different methods

<table>
<thead>
<tr>
<th>Principle</th>
<th>Pro’s</th>
<th>Con’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual Comparison</td>
<td>- Easy to use</td>
<td>- Value depends on experience</td>
</tr>
<tr>
<td></td>
<td>- Low investment</td>
<td>- No analysis of turbidity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Not suitable for beer-mix beverages</td>
</tr>
<tr>
<td>Photometry</td>
<td>- High reproducibility</td>
<td>- Only for clear products</td>
</tr>
<tr>
<td></td>
<td>- Colour matching based on spectrum</td>
<td>- Measurement does not correlate to visual analysis</td>
</tr>
<tr>
<td>Colorimetry</td>
<td>- Results comparable to visual analysis</td>
<td>- High investment</td>
</tr>
<tr>
<td></td>
<td>- Appearance is analysed, not only colour</td>
<td>- Values not comparable between instruments and methods</td>
</tr>
</tbody>
</table>

### Images
- ![The Lovibond® AF 330](image1.png)
- ![Hunterlab ColourQuest XE](image2.png)
Multi-Sensory Experience
Perception of colours
Colour measurement
References & presenters
Colour measurement in beer-mix beverages

References


**Colour measurement in beer-mix beverages**

**Presenters**

<table>
<thead>
<tr>
<th>Dr. Jean Titze</th>
<th>Christine Thomas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jean Titze worked as a Brewery Consultant for the Research Center Weihenstephan and later on as a Senior Consultant for Deloitte &amp; Touche focusing on the food and beverage industry for several years.</td>
<td>Christine Thomas studied Food Technology at the University of Hohenheim with a focus on Plant Foodstuff and Dairy Technology. She started working for Döhler in the context of her diploma thesis on carotenoid micro emulsions.</td>
</tr>
<tr>
<td>After that, he lived in Ireland for two years working as a Senior Research Scientist and Brewery Manager for the National University of Ireland at University College Cork. Since April 2013 he has been working at Döhler GmbH and is now Head of R&amp;I Cereal Ingredients.</td>
<td>After working as a Developer in the team of R&amp;D Colours and Ingredients for one year she took over the position of Head of R&amp;I Colours in 2013.</td>
</tr>
</tbody>
</table>
Thank you very much for your attention.
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