Development of cocoa physical reference samples for training and calibration of sensory evaluation panels: Perspectives from a range of food products

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Objective & Methodology

- Review the use of physical reference samples of different food products, to guide the development of such references for training and calibration of sensory evaluation panels for cocoa products.
- 149 articles reviewed

- Descriptive sensory analysis
- Sensory panel screening and training
- Lexicon development
- Physical reference standards
- Flavour chemistry
- Sensory perception

Screening

- 2010 onwards
- Experimental studies
- Descriptive sensory analysis; flavour lexicon development; physical reference standards
- Presence of panel training
- Products

References classification

- Beer & wine: 17
- Bread and grains: 15
- Cocoa products: 19
- Coffee and tea: 16
- Dairy products: 19
- Fruits and vegetables: 17
- Oils, emulsions and nuts: 18
- Traditional and ethnic products: 12

Comparison & Analysis

- Product category
- Type of descriptive sensory analysis
- Purpose of lexicon generation
- Frame of reference
- Type of physical references
- Rating scale used
- Scale increments
- Overall effect on panel training
Fundamental concepts

• A physical reference standard is any material (non-food, chemical, food, or combination thereof) that clearly characterizes a specific product attribute, usually beyond the capacity that verbal descriptors provide in aligning a panel to describe and quantify sensory perceptions (Lawless and Heymann, 2010; Muñoz and Civille, 1997; Rainey, 1986).

Crucial for:
• Maximizing language clarity especially in cross-cultural settings
• Minimizing “within panel” variation in rating attribute intensities
• Reducing time for training and calibrating panellists
The majority (94%) of these publications involved the use of conventional descriptive analysis as follows:
• Generic Descriptive Analysis/GDA (55%)
• Quantitative Descriptive Analysis/QDA (34%)
• Spectrum™ (4%)
• Flavour Profile/FP (1%).

Purpose of descriptive sensory methods:
• Quality and/or process control (46%)
• Product and/or process development (28%)
• Shelf-life testing (9%)
• Others (17%)
Results - Use and type of references

[ Development and/or Use of Physical References? ]

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Products</td>
<td>87%</td>
<td>13%</td>
</tr>
<tr>
<td>Alcoholic Beverages</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Bread and Grains</td>
<td>73%</td>
<td>27%</td>
</tr>
<tr>
<td>Cocoa</td>
<td>89%</td>
<td>11%</td>
</tr>
<tr>
<td>Dairy</td>
<td>79%</td>
<td>21%</td>
</tr>
<tr>
<td>Fruits and Vegetables</td>
<td>81%</td>
<td>19%</td>
</tr>
<tr>
<td>Meat</td>
<td>94%</td>
<td>6%</td>
</tr>
<tr>
<td>Non-Alcoholic Beverages</td>
<td>94%</td>
<td>6%</td>
</tr>
<tr>
<td>Oils, Emulsions, and Nuts</td>
<td>83%</td>
<td>17%</td>
</tr>
<tr>
<td>Traditional and Ethnic</td>
<td>92%</td>
<td>8%</td>
</tr>
</tbody>
</table>

Percentage of studies, according to product category, indicating the development and/or use of physical references during the training phase of descriptive sensory panellists.

Type of references distribution across products

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Conclusions

• Urgent need in cocoa producing countries to build capacity of national panels for a better understanding of cocoa quality and flavour potential for increased value and profitable production.

• Reference samples are:
  • critical for training and generation a commonly agreed glossary of terms
  • essential to ensure panel’s performance in terms of repeatability, discrimination and alignment

• Specific recommendations for the development of cocoa-specific physical references
Pilot – Cocoa of Excellence

• Objective: Strengthen capacity on quality and flavour evaluation at national level as part of the USDA-funded project MOCCA – Maximizing Opportunities in Coffee and Cacao in the Americas

• Different approaches for beginners and experienced trainees

• In 5 Latin-American countries:
  • Ecuador – 23 experienced
  • El Salvador – 16 beginner
  • Guatemala – 20 beginner
  • Honduras – 16 beginner
  • Peru – 16 experienced
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Cocoa of Excellence vocabulary

Glossary

Flavour wheel

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensity</td>
<td>Meaning</td>
</tr>
<tr>
<td>0</td>
<td>Absent</td>
</tr>
<tr>
<td>1</td>
<td>Just a trace and may not be found if tasted again</td>
</tr>
<tr>
<td>2</td>
<td>Present in the sample but at low intensity</td>
</tr>
<tr>
<td>3 to 5</td>
<td>Clearly characterizing the sample</td>
</tr>
<tr>
<td>6 to 8</td>
<td>Dominant characterization of the sample</td>
</tr>
<tr>
<td>9 to 10</td>
<td>Maximum. Strong intensity. Overpowers some other flavour notes in the sample</td>
</tr>
</tbody>
</table>

NOTES on examples of origin typical of intensity level

- These examples are for illustrative purposes only and are not meant to be exclusive of any origins/types.
- Specific lots of individual origins can differ dramatically from these frequently encountered values.
- Currently available, widely traded and traditionally known origins and may be reviewed in future editions.

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Description</th>
<th>Intensity level</th>
<th>References notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cocoa</td>
<td>Typical flavour of roasted cocoa beans that are well-fermented, dried, free of defects.</td>
<td>0 – 2</td>
<td>Under-fermented cocoa, ancient Criollo.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 – 5</td>
<td>Appropriately fermented “Nacional” and Papua New Guinean lots.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 – 8</td>
<td>Appropriately fermented cocoa, some West African and some Dominican Republic Hispaniolan lots.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9 – 10</td>
<td>Some West African lots.</td>
</tr>
<tr>
<td>Acidity</td>
<td>Perception of acidity intensity is particularly dependent on the amount of sample in the mouth. Total acidity is the sum of the following individual acidities:</td>
<td>0 – 2</td>
<td>Some well-prepared West African lots.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 – 5</td>
<td>Some Ecuadorian, Peruvian and Central American lots.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 – 8</td>
<td>Some Dominican Republic Hispaniolan, Papua New Guinean and Malaysian lots.</td>
</tr>
</tbody>
</table>
Cocoa of Excellence vocabulary
Type of references used

• Chemical based – screening exercises and references
  • Basic tastes: 5
  • Common aromas: ~ 15
  • Off-flavours: ~ 3

• Food based references
  • Core attributes: ~ 7
  • Complementary attributes: ~ 26

• Non-food based references – to smell only
  • Complementary attributes: ~ 13

• Matrix based references
  • Cocoa of Excellence Diversity Kit 22 cocoa liquors showing flavour diversity and showcasing specific attributes
  • Cocoa liquors with off-flavours
Testing training effectiveness

• Questions:
  • Do skills of panellists improve with the training?
  • Does data show an improvement?

• Methodology:
  • Cocoa of Excellence sensory evaluation tools
  • References of all types
  • Panel performance assessment – Panel Check
  • Cocoa liquor profiles

• Participants
  • 10 experienced cocoa liquor tasters
  • New to Cocoa of Excellence methodology

• Samples:
  • 2 sets of 9 blinded cocoa liquors in triplicates
  • Different flavour attributes
  • Different global quality

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### Results – Individual repeatability

- **Repeatability was assessed by the calculation of the Mean Square Error (MSE) for each attribute with Panel Check.**
- **The lower the MSE, the better the repeatability**
- **9/10 individual panellists improved their repeatability after the training**

<table>
<thead>
<tr>
<th>F Nr.</th>
<th>Attribute</th>
<th>March MSE</th>
<th>March MSE</th>
<th>Sept MSE</th>
<th>Sept MSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cocoa</td>
<td>1.20</td>
<td>0.32</td>
<td>0.24</td>
<td>0.24</td>
</tr>
<tr>
<td>2</td>
<td>Acid_Total</td>
<td>7.44</td>
<td>0.56</td>
<td>0.52</td>
<td>0.52</td>
</tr>
<tr>
<td>3</td>
<td>Bitterness</td>
<td>3.80</td>
<td>0.29</td>
<td>0.26</td>
<td>0.26</td>
</tr>
<tr>
<td>4</td>
<td>Astringency</td>
<td>1.32</td>
<td>0.32</td>
<td>0.24</td>
<td>0.24</td>
</tr>
<tr>
<td>5</td>
<td>Frukt_Total</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>6</td>
<td>Bfrukt_Total</td>
<td>2.14</td>
<td>2.17</td>
<td>2.17</td>
<td>2.17</td>
</tr>
<tr>
<td>7</td>
<td>Floral_Total</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>8</td>
<td>Wood_Total</td>
<td>3.72</td>
<td>3.72</td>
<td>3.72</td>
<td>3.72</td>
</tr>
<tr>
<td>9</td>
<td>Spice_Total</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>10</td>
<td>Nutty_Total</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>11</td>
<td>Panell</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>12</td>
<td>Roast</td>
<td>2.34</td>
<td>2.34</td>
<td>2.34</td>
<td>2.34</td>
</tr>
<tr>
<td>13</td>
<td>Off_Total</td>
<td>2.78</td>
<td>2.78</td>
<td>2.78</td>
<td>2.78</td>
</tr>
<tr>
<td>14</td>
<td>GQ</td>
<td>0.06</td>
<td>0.06</td>
<td>0.06</td>
<td>0.06</td>
</tr>
</tbody>
</table>

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Results – use of scale and discrimination

- The alignment among panellists increased in terms of use of the scale range for most attributes
- Power of differentiation increased for most attributes
Results – Flavour profiles

D 1009

D 1017

D 1015

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THANK YOU!

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