For the accuracy of the study, how should we control sample preparation and presentation procedures?

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“Good sensory specialist will always follow the standard practices because that would help ensure that he/she will obtain consistent, actionable data. However, an experienced sensory scientist will occasionally break the standard practice guidelines. When one breaks these rules one always has to be fully aware of the consequences, the risks entailed, and whether one still can get valid data from the study. “

Case study 1. Green tea: Descriptive analysis

The study was designed to investigate the sensory characteristics of 3 different types of green tea samples.

However, achievement of the study’s objective was not an easy task as one may think.
How should we prepare green teas for sensory evaluation?
What are the conditions that we need to consider?

<table>
<thead>
<tr>
<th>Tea/ water ratio</th>
<th>Infusion time</th>
<th>Infusion temp.</th>
<th>Water type</th>
<th>Type of tea</th>
</tr>
</thead>
</table>

Sensory characteristics of green tea are *markedly affected* by these factors…

**Koreans** traditionally infuse their teas at 60°C, while in other countries people infuse their teas at different temperatures (80–90°C).

- At which temperature should the teas need to be prepared?
- For how long should teas need to be infused?
- How should we determine all these?

A study was designed to determine the optimum infusing time of green tea at different infusing temperatures.

**What is the just-about-right (JAR) infusion for consumers?**

- Optimum infusing time and temperature were to be determined.

✓ Three types of green teas (AU, AS and AH) were used.
✓ **Two temperatures** (60°C or 80°C) were selected for infusion.
✓ For the two selected temperatures, **teas were infused for various times** (0.5, 1.5, 2.5, 3.5, 4.5 and 5.5 min)
✓ **Just-about-rightness (JAR) of infusion** was evaluated for each condition (temp x type).
Sample preparation

Which container should be used to infuse the green tea?

Compared two containers:
Beaker vs. Erlenmeyer flask

* The aim was…
to find the container that kept more green tea odors during infusion.

⇒ Flavors were better detected when the green tea was prepared in an Erlenmeyer flask.
⇒ Green tea leaves of 17 g was put into an 1L Erlenmeyer flask.

Sample preparation

Green tea characteristics get highly affected by infusing temperature.

The selected infusing temperatures are pretty high (60°C or 80°C) and it can easily cool down while infusing the teas!!!

✓ Maintaining the temperatures during infusion was required!!!
1. The flask was pre-heated before usage.

2. Waterbath was used to maintain the temperature during infusing the tea.

3. Infusions were put into a pre-warmed large thermos.

Sample presentation

- In general, sensory characteristics are perceived differently when the temperature of the sample differs.

- Maintaining the sample temperatures during evaluation was required!!!

- The infusion in the large thermos was distributed into several small thermoses (pre-warmed) to maintain the temperature of the samples throughout the evaluation.

- Small thermoses were presented to the panelists along with glass beakers.

- The prepared teas were used within 30 minutes after infusion.
Regression analysis:

- Optimum infusing times at different infusing temp. for green teas were determined:
  - Optimum infusing time was determined as 3 min at 60°C
  - Optimum infusing time was determined as 1 min at 80°C

This technique was applied for sensory evaluation of various types of green teas with some modifications.

- Chemical composition of green teas according to processing methods and extraction conditions (Kim, Y-K., Oh, Y-J., Chung, J-O., Lee, S-J. and Kim, K.O. 2009. Food Sci and Biotechnol, 18: 1212-1217)
Case study 2. Fermented tea: Cross-cultural descriptive analysis

The study was designed for cross-cultural comparison: to investigate how French and Korean trained panel describe sensory characteristics of 7 tea samples, which differed not only in origins but also in their manufacturing processes.

Sample preparation

Depending on the type of infusing water, not only color, but also flavor of the infused tea can vary greatly.

✔ Water for tea infusion should be the same for Korea and France.

➔ Evian was being sold in both countries, thus selected for tea preparation!
Sample preparation

Depending on the levels of fermentation, color of the tea infusions differ dramatically.

✓ Sample presentation method that masks the color among different fermented teas was required for the evaluation of tea flavor.

The prepared fermented tea infusions were presented in black ceramic cups in order to avoid the influence of color differences among the samples.

Sample showing the color range of fermented teas used in the study.

<table>
<thead>
<tr>
<th>Tea leaves</th>
<th>Infused teas</th>
<th>Sample presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Tea leaves" /></td>
<td><img src="image2.png" alt="Infused teas" /></td>
<td><img src="image3.png" alt="Sample presentation" /></td>
</tr>
</tbody>
</table>
Sample preparation and presentation

- In order to maintain the temperature of the samples throughout the evaluation, the samples were presented in thermoses along with black ceramic cups.

In order to prevent differences that may occur due to the experimental settings between Korea and France...

- the same thermoses and the same ceramic cups used for the Korean panel were shipped to France.

This technique was applied in cross-cultural descriptive analysis for fermented teas.

The influence of cultural differences on descriptive analyses of fermented tea products between Korean and French panels (Kim, Y-K. Valentine, D. and Kim, K.O. In preparation.)
Case study 3. Soy sauce: Descriptive analysis

The objective of the study was to examine the sensory characteristics of 6 fermented type soy sauces with high market share in Korea.

However, achievement of the study’s objective was not an easy task because of the very intense flavor characteristics of soy sauce.

How should we prepare samples for sensory evaluation of soy sauce?

Panelists were having difficulties when they tasted the samples because of the overpowering intensity of salty taste.

- It was required for the samples to be tasted without too much difficulty.
- It was necessary to prepare the samples for the panelists to differentiate the complex flavors of soy sauce.
Sample preparation for soy sauce...

Compared different dilutions of soy sauces.

- Undiluted
- 2:1 soy sauce to water dilution
- 1:1 soy sauce to water dilution
- 1:2 soy sauce to water dilution

* Issues...
When the sample was diluted, some sensory characteristics were not well detected. However, when the sample was not diluted, strong adaptation effect was observed.

• Solution:
Flavors were best detected when soy sauce was not diluted!
⇒ Dilution was given up.

Sample presentation method

When soy sauce was served in opened cups, air of the sensory area was easily contaminated because of the strong smell of soy sauce.

✔ Container causing minimum air contamination was required.

Compared various containers...

* The aim was...
to hold the soy sauce odor within the container as much as possible without air contamination.
Sample presentation method

**Effective control** on the **amount of sample** for tasting during sensory evaluation was required **not to cause fatigue as well as air contamination.**

**Compared different dispensers...**

- **Spoon**
- **Pasteur pipette**
- **Glass bar**

* The aim was…
  to effectively handle the very small portion of sample to be consistently delivered to the panelists.

**Solution:**

1. A **50-mL closed bottle equipped with pasteur pipette** was selected.

2. **Amber bottles** were selected so that the color differences can be masked.

3. **Melamine spoon** (that has little lingering of odors even for a long usage) was used to deliver two drops of soy sauce samples from the pasteur pipette.
Individual panelist was able to discriminate the differences among the sample for most of the attributes. Individual panelist and the rest of the panel showed high correlation ($r>0.80$) for most of the attributes, which implies strong consensus among the panelists in evaluating the samples.

This technique was applied in descriptive analysis for soy sauce.


Case study 4. Balsamic vinegar: Cross-cultural consumer test

This study was designed for cross-cultural comparison: to investigate how Italian and Korean consumers perceive the sensory characteristics of balsamic vinegar similarly or differently.

To get the accurate results, the test environmental conditions for both countries had to be identical.

Sample presentation for balsamic vinegar...

Similar to soy sauce case, balsamic vinegar also has intense odor and flavor, it is important to control air contamination and amount of sample size for tasting.
Sample presentation for balsamic vinegar...

Sample presentation method for descriptive analysis of soy sauce was adopted.

- Sample was served in a 50-mL amber colored bottle equipped with pasteur pipette.

To evaluate the balsamic vinegar samples, suitable amount of sample size was determined with preliminary test.

- 2 drops of samples (avg. 0.083 g, range 0.079 - 0.085 g)

Sample presentation for balsamic vinegar...

Compared the sample colors in individual booth under various colored lights for masking color of the samples.

- Red light
- Blue light
- Green light

- Result:
  Blue light was chosen.

✓ To make identical experimental settings between two countries, the serving containers were shipped from Korea to Italy.
This technique was applied in preparing balsamic vinegar samples for cross-cultural consumer testing.


Case study 5. Toothpaste: Descriptive analysis

How should we conduct sensory (flavor) evaluation of toothpaste?

Is tooth brushing required?

If consecutive tooth brushing is applied for the sensory test of toothpastes, oral pain and memory loss could be caused, thus affecting panel performance.

If tooth brushing had to be avoided, what was the alternative protocol?

✔ It still has to give similar taste and flavor feeling. (Hightower and Chambers (2009) compared tooth brushing to spoon tasting. The characteristics perceived in spoon tasting method gave somewhat different characteristics to tooth brushing, derived from uneven spreading of toothpaste flavor)

✔ Toothpaste should spread evenly throughout the oral cavity.

✔ Similar feelings to expectoration stage had to be obtained.
- Toothpaste becomes a mixture of toothpaste and saliva when being expectorated: It is diluted with saliva. Therefore, diluted toothpaste, similar to the expectorating stage of toothpaste, had to be prepared.

1. Determining the dilution procedure

- Diluting toothpaste samples with water using mortar:
  - A Mortar
  - Mixing toothpaste with water
  - Homogeneous mixture

   ![Images of mortar, mixing toothpaste, and homogeneous mixture]

   It had to be consumed within a hour due to separation problem.

2. What is the adequate ratio of toothpaste to water?

- The amount of mixture of toothpaste and saliva when expectorating was measured:
  - Thirty subjects brushed teeth for 30 s using 1 g of toothpaste.
  - They expectorated the mixture of toothpaste and saliva.
  - The amount of expectoration was 2.3 g.
3. What should be the level of dilution?
- 2.3 g of expectoration contain part of toothpaste, but not all. Some remains in the mouth. Considering this, diluted toothpaste was prepared with toothpaste : water ratios of 1:2, 1:3, 1:4 and 1:5.

- Panelists compared the feelings in oral cavity after 30s of tooth brushing with 1g of toothpaste to the feeling of tasting 10ml of each diluted toothpaste.

- Proper ratio of the toothpaste-to-water was determined as 1:4.

4. Descriptive analysis of toothpaste flavor
- Eight diluted toothpaste samples were applied to identify flavor characteristics of toothpastes.

Fig.3. PC loadings of the sensory attributes (a) and toothpaste samples (b) for dimensions 1 and 2

5. Consumer acceptability test for toothpaste
- This protocol was applied also to consumer acceptability test.

The effects of sensory and nonsensory factors on consumer acceptability and purchase intention of commercial toothpaste (Kim, J.Y. and Kim, K.O. J Sens Stud. Under revision)

6. Practical application
- The company modified the formulas of their toothpastes.

Case study 6. Soup: Just-About-Right Saltiness

When sensory analysis is performed in a laboratory environment, experiment equipments are often used for serving containers.

For example, beakers.

But, would it matter when you perform sensory tests with consumers?

⇒ The answer is yes.
This study was designed to investigate the effect of tasting protocols on Just-About-Right (JAR) saltiness scores in two different soup systems, soybean-sprout soup and chicken soup, containing six different levels of salt, respectively.

**Tasting protocols**

- **A beaker-tasting protocol (BTP)**
  - Samples (70ml) were presented in 100 ml laboratory beakers
  - The samples were consumed directly from the beakers

- **A spoon-tasting protocol (STP)**
  - Samples (70ml) were presented in soup bowls (diameter: 115mm, depth: 50mm)
  - The samples were consumed with spoons
**Procedure**

- Participants attended 2 sessions for BTP and STP on separate days.
- Participants evaluated level of saltiness for the 6 samples in each soup system, respectively using a 15-point JAR scale.

Fig 4. Order of tasting protocols and soup systems
Table 3. F-values from the ANOVA applied to the JAR scores of samples in each soup system

<table>
<thead>
<tr>
<th>Soup system</th>
<th>Source</th>
<th>df</th>
<th>F-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean-sprout soup</td>
<td>Tasting protocol</td>
<td>1</td>
<td><strong>50.14</strong></td>
</tr>
<tr>
<td></td>
<td>Sample</td>
<td>5</td>
<td><strong>813.36</strong></td>
</tr>
<tr>
<td></td>
<td>Tasting protocol*Sample</td>
<td>5</td>
<td>2.13</td>
</tr>
<tr>
<td>Chicken soup</td>
<td>Tasting protocol</td>
<td>1</td>
<td><strong>12.19</strong></td>
</tr>
<tr>
<td></td>
<td>Sample</td>
<td>5</td>
<td><strong>671.23</strong></td>
</tr>
<tr>
<td></td>
<td>Tasting protocol*Sample</td>
<td>5</td>
<td>0.31</td>
</tr>
</tbody>
</table>

* Result:
- The sample tasting protocol significantly affected the perception of saltiness in both soup systems (P < 0.01).
- The effect of tasting protocol was stronger in the soybean-sprout soup system than in the chicken soup system.

Table 4. The mean JAR saltiness scores of samples in each soup systems

<table>
<thead>
<tr>
<th>Soup system</th>
<th>Tasting protocol</th>
<th>Salt level (%, w/v)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.2 (0.1)1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.4 (0.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.6 (0.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.8 (0.7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0 (0.9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.2 (1.1)</td>
</tr>
<tr>
<td>Soybean-sprout soup</td>
<td>BTP</td>
<td>-4.49a2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-1.50b</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.86c</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.44d</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.10e</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.91f</td>
</tr>
<tr>
<td>STP</td>
<td></td>
<td>-4.53a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-2.24b</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.22c</td>
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<tr>
<td></td>
<td></td>
<td>1.69d</td>
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<td>3.10e</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.94f</td>
</tr>
<tr>
<td>Chicken soup</td>
<td>BTP</td>
<td>-3.27a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-1.28b</td>
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<td>3.26e</td>
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<tr>
<td></td>
<td></td>
<td>4.42f</td>
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<tr>
<td>STP</td>
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<td>-1.64b</td>
</tr>
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<td></td>
<td>1.77d</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.09e</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.93f</td>
</tr>
</tbody>
</table>

1) Numbers in parenthesis indicate salt levels for chicken soup system
2) Means not sharing a superscript letter within a row are significantly different (Duncan's multiple range test. P < 0.05)

* The mean JAR values of saltiness were higher in all six soup samples in both soup systems with BTP than with STP.
• The optimal level (just-about-right level) of NaCl determined by a simple linear regression model:
  - In soybean-sprout soup system, the optimal NaCl concentration determined with BTP was 0.59%, whereas 0.66%, with STP.
  - In chicken soup system, the optimal NaCl concentration determined with BTP was 0.48%, whereas 0.52% with STP.

• The optimal NaCl concentrations determined with BTP were lower than those determined with STP for both soup systems.

• In normal-life situations, soup is usually served in a bowl and eaten with a spoon. It is assumed that the frame of saltiness perceptions of the participants have changed when they tasted the soup from the beaker, and this appeared to be confirmed by the JAR scores of saltiness.
• These findings emphasize the importance of controlling the sample presentations and tasting protocols in sensory tests to determine the optimal level of ingredient concentrations of food products.


Conclusion

• Sample preparation, presentation and evaluation protocols DO influence your outcome!

• Ill practice will ruin good sensory methodology, statistical analyses, etc.

• For good sensory evaluation practice, time and efforts to prepare and present samples in proper ways should not be given up!

• It is not an easy task to consider various variables and to come up with a proper solution for it. Lots of creativity is needed, and it is your job to stay creative!