

# RTBfoods Manual - Part 2 - Tutorial

## Monitoring Panel Performance and Cleaning Data from Descriptive Sensory Panels for Statistical Analysis

Biophysical Characterization of Quality Traits, WP2

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Ethics: The activities, which led to the production of this manual, were assessed and approved by the CIRAD Ethics Committee (H2020 ethics self-assessment procedure). When relevant, samples were prepared according to good hygiene and manufacturing practices. When external participants were involved in an activity, they were priorly informed about the objective of the activity and explained that their participation was entirely voluntary, that they could stop the interview at any point and that their responses would be anonymous and securely stored by the research team for research purposes. Written consent (signature) was systematically sought from sensory panelists and from consumers participating in activities.

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# ABSTRACT

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Abstract: After the training phase, panelists can assess the sensory characteristics of cooked products. The objective of this tutorial is to check the performance of the panel (repeatability and homogeneity with the panel) at the end of the analyses and organize the data for further statistical analysis. The tutorial is divided into two sections for different study designs: one in which only one sample is repeated at each session, and another where all samples are repeated at each session. A fictional example which demonstrates all the steps is presented in an Excel file provided with the tutorial. Basing on our own experience, we have set several rules to check the performance of the panel and organise the final data. This allows us to eliminate non-performing panelists or unacceptable data. Another tutorial will be written on the statistical analysis of sensory data, including principal component analysis (PCA) and linear regressions (simple and multiple) to relate sensory attributes to instrumental data.

**Key Words:** sensory profile – panel's performance – repeatability – homogeneity – data validation - mean

# AIM: MONITORING PANEL PERFORMANCE AND ORGANISING SENSORY DATA

In the previous tutorial (RTBfoods\_E.2.2\_2018.pdf), we presented the steps to assess panel performance after completion of the training phase. At the end of this training, your panel is composed of the best performing panellists who are repeatable, discriminative and in agreement with the whole panel.

These panellists will then evaluate a number of products according to a list of sensory attributes by scoring on a discrete 11-point scale ranging from 0 to 10. The instructions below cannot be applied for some attributes that will be evaluated on a binomial scale (yes - no), if any.

During this product evaluation, you have presented some samples in duplicate/triplicate to monitor the performance of your panel. You may have chosen to repeat either a single sample or all samples during each session. Whatever your strategy, raw data could be directly used for statistical analysis (PCA, linear regression, etc.). You must organise your data such that it is acceptable for statistical analysis depending on the performance level of you panel.

**The objective of this tutorial is therefore to provide instructions on how to monitor the performance of your panel throughout the analyses performed and prepare your data for further statistical analysis.**

In the following section of the document, we propose two tutorials corresponding to the strategy you have chosen:

- 1- One sample is repeated (presented in duplicate) at each session
- 2- All samples are repeated (presented in duplicate) at each session.

In both cases, the tutorial is based on a fictional example presented in an Excel file that will guide you through all the steps.

NB: we will not go back over the Excel commands in this tutorial because they were covered in the previous tutorial (RTBfoods\_E.2.2\_2018.pdf).

## 1 ONE SAMPLE IS REPEATED (PRESENTED IN SUPPLICATE) AT EACH SESSION

In this example, the panel consists of 13 panellists who evaluated 11 products of boiled plantain during 3 sessions on 5 descriptors using a scale ranging from 0 to 10 and 2 descriptors on a binomial scale (yes / no). Some panellists did not participate in all sessions for example, panellist 5 was absent in session 1 while panellist 8 was absent in sessions 2 and 3.

### 1.1 Input and sort raw data

Open the Excel file « [RTBfoods\\_F.2.4\\_Tutorial for Performance Monitoring Sensory Data Cleaning Before Statistical Analysis\\_Annex1\\_2021.xls](#) ».

- 1- In the **Samples** tab, enter the data relating to the samples to be tasted. **Do not forget to enter the BreedBase references.**
- 2- In the **Panel** tab, enter the data relative to the panellists (name, first name, panellist code).

- 3- In the **Raw data** tab, enter the results from the tasting sessions, specifying the repetition and session number. Sort the data first by session and then by Sample code (see 2-level sorting in the RTBfoods\_E.2.2\_2018.pdf tutorial, p35-36).

## 1.2 Evaluate panel repeatability and prepare data

To optimise the repeatability of the panellists, we have set four rules:

- **repeatability is efficient if the difference (in absolute value) between two observations is less than or equal to 3 on a scale of 0 to 10.**
- **If a panellist was not repeatable for an attribute in a session, then the scores made by that panellist for that attribute are dropped for all products in that session.**
- **a panellist who has been repeatable for an attribute at more than 50% of all sessions is repeatable for that attribute.**
- **If a panellist who is not repeatable for more than 50% of the attributes, should be eliminated from the panel.**

NB: we propose here a less restrictive rule than for the evaluation of the panel's performance during training sessions (RTBfoods\_F.2.2\_2018.pdf, p32) where we had set a gap less than or equal to 2. L'objectif est d'avoir au moins 8 panélistes répétables pour chaque produit à la fin de la préparation des données.

- 1- In the **Only replicate** tab, copy-paste the results extracted from the raw data for only the repeated products (here Ngr J4, Mol J4 and Or J0) excluding the attributes evaluated on a binomial scale.
- 2- In the **Repl\_firmness** tab, copy on 2 successive columns (here D and E) the results of the replicates for each of the replicate samples by notifying the corresponding tasting session.
- 3- The difference in absolute value is displayed in the next column (here F). The calculation is automatic.
- 4- In the **synthesis** table (H1:N14), the results of the differences between replicates for all sessions are automatically displayed. This table must be constructed according to the number of sessions, and panellists. If a difference between 2 repetitions is less than or equal to 3, then the panellist has been repeatable for this attribute and for this session (a "yes" is displayed) (**rule 1**).
- 5- The number and % of yes is calculated automatically. If the % of 'yes' is greater than 50%, then the panellist is repeatable for this attribute (an "OK" is displayed). Attention, this rule must take into account the fact that some panellists do not participate in all sessions (panellists 5 and 8).
- 6- Apply these instructions for all other sensory attributes.
- 7- In the **Summary on repeatability** tab, copy and paste in the corresponding columns (B, C, D...) the last column of the previous **Repl-xxxx** tabs (here R) summarizing the performance in terms of repeatability of all panellists.
  - Columns (G and H) specify the % of times that the panellist was not repeatable for all attributes.
  - If this % is strictly higher than 50%, then it is displayed as "panellist not repeatable at all". All these scores will be eliminated (**rule 3**). This is the case here of panellist N°1.
  - For each attribute, it is displayed if the panellist is repeatable (-) or not (panellist not repeatable for this attribute). In the latter case, all the scores of this panellist for this attribute will be eliminated (**rule 2**).
- 8- In the **Data before cleaning** tab, copy-paste the table from the **Raw data** tab. Locate the non-repeatable panellists for all attributes (here panellist 1) or some attributes (for example panellists 4 and 12 for firmness). When the panellist is not repeatable for an attribute in one session only (this is visible in the synthesis table for each attribute), all data for that attribute and for that session only are deleted (e.g. for sweetness,



panellist 4's data is deleted for session 1 and panellist 7's data for session 3). All data not previously validated are marked in red and are then actually deleted in the **Data after cleaning** tab.

*Recommendations: In the example, we have deleted the data of panellist 1. The facilitator will occasionally have to inform him/her of these counter-performances and possibly re-train him/her for future sensory analysis. For the other panellists, the facilitator should inform them about their underperformance for a particular attribute (for example, panellists 4 and 12 are not repeatable for the Firmness attribute).*

## 1.3 Evaluating the panellist's agreement with the panel and organising/cleaning the data

In order to optimise the agreement of the panellists with the panel, we have set ourselves three rules:

- **The agreement is effective if the difference (in absolute value) for a given product between the average score of the panel and that of each panellist is less than or equal to 3 on a scale of 0 to 10.**
- **If, for an attribute, more than 50% of a panellist's data does not agree with the panel, then that panellist's data for that attribute is discarded.**
- **If the panellist is not in agreement with the rest of the panel for more than 50% of the attributes, then the panellist is removed.**

NB: we propose here a simpler rule than for the evaluation of the panel's performance during training sessions (RTBfoods\_E.2.2\_2018.pdf, p33) where we had set a deviation of 70% from the standard deviation of the panel. L'objectif est d'avoir au moins 8 panélistes en accord avec le panel pour chaque produit à la fin de la préparation des données.

- 1- In the **Agreement with panel** tab, copy-paste the data from the **Data after cleaning** tab. Insert a row per product to display the means by sensory attribute.
- 2- For each product and each attribute, the absolute difference between the panel mean and the panellist score is automatically displayed (columns M to Q). All missing data ("not applicable") and data greater than 3 are displayed in red (use the Conditional Formatting command in the Excel menu).
- 3- Highlight (in orange here) in the initial data (columns G to K) the scores associated with the cells in red (columns M to Q).
- 4- In the **Summary on agreement** tab, copy and paste (value and format) the columns B (panellists) and M to Q (attribute deviation) from the **Agreement with panel** tab. Sort by panellist. Display for each panellist the number of times he or she has disagreed with the panel. Some boxes are displayed "not repeatable". Here, the number of times a panellist disagreed with the panel on an attribute did not exceed 3 out of 14 products evaluated (well below 50%) therefore no panellist was removed for any attribute.

*Recommendations: In the example, panellist 13 was in least agreement with the panel for the attributes mealiness (3) and sweetness (3) but this remains acceptable on the number of products analysed (14). However, the facilitator should review the data from this panellist and discuss with him/her again the understanding of the use of the scale and the need for further training for future analyses.*



In our example, at least 8 panellists have been selected for the final evaluation of each product. However, for some "products x sensory attribute" combinations, the number of panellists was 7 (for example, to evaluate the mealiness). This is reasonable and inconsequential for data processing.

## 1.4 Prepare the final tables

The final mean table displays the average values obtained by the panel for each product, each attribute on a scale of 0 to 10. For attributes evaluated on a binomial scale (yes / no), the average score corresponds to a frequency of "yes" on a scale of 0 to 10.

- 1- In the **data\_mean** tab, copy and paste the data from the **Agreement with panel** (by removing orange data). For the attributes evaluated on a binomial scale (here sourness and astringency), a frequency of "yes" is calculated and then brought back to a scale from 0 to 10 to be able to compare these attributes with the other attributes evaluated on a scale from 0 to 10.
- 2- In the **mean per product** tab, copy and paste the data from the **data\_mean** tab, display the name of the products in front of the Mean line, then delete the panellists' lines.

**This table is the one that will be used afterwards for all graphical (radar) and statistical analysis (PCA, linear regressions).**

In the **Final data** tab, copy and paste the previous data from **data\_mean** and delete all the mean values and intermediate headers. **This table is the final table cleaned of all data which are not repeatable and not in agreement with the panel.**

## 2 ALL PRODUCTS ARE REPEATED

In this example, the panel consists of 13 panellists who evaluated 6 products of boiled plantain during 3 sessions on 5 descriptors using a scale ranging from 0 to 10 and 2 descriptors on a binomial scale (yes / no). Each product has been replicated in each session. Some panellists did not participate in all sessions (panellist 5 for session 1 and panellist 8 for sessions 2 and 3).

### 2.1 Input and sort raw data

Open the Excel file « [RTBfoods\\_F.2.4\\_Tutorial for Performance Monitoring Sensory Data Cleaning Before Statistical Analysis\\_Annex2\\_2021.xls](#) ».

- 1- In the **Samples** tab, enter the data relating to the samples to be tasted. **Do not forget to enter the BreedBase references.**
- 2- In the **Panel** tab, enter the data regarding the panellists (name, first name, panellist code).
- 3- In the **Raw data** tab, enter the results of the tasting sessions, specifying the repetition and session number. Sort the data first by session and then by Sample code (see 2-level sorting in the RTBfoods\_E.2.2\_2018.pdf tutorial, p35-36).

### 2.2 Evaluate panel repeatability and prepare data

To optimise the repeatability of the panellists, we have set four rules:

- **repeatability is efficient if the difference (in absolute value) between two observations is less than or equal to 3 on a scale of 0 to 10.**

- If a panellist was not repeatable for a product in a session, then that data for that attribute and product is discarded.
- A panellist is repeatable for an attribute if it has been repeatable at more than 50% over all products.
- If a panellist is not repeatable for more than 50% of the attributes, then he or she is eliminated from the panel.

NB: we propose here a less restrictive rule than for the evaluation of the panel's performance during training sessions (RTBfoods\_F.2.2\_2018.pdf, p32) where we had set a gap less than or equal to 2. **The goal is to have at least 8 repeatable panellists for each product at the end of data preparation.**

- 1- In the **Repl\_firmness** tab, copy on 2 successive columns (here D and E) the results of the replicates for each of the replicate samples by notifying the corresponding tasting session.
- 2- The difference in absolute value is displayed in the next column (here F). The calculation is automatic.
- 3- In the **synthesis** table (H1:X15), the results of the differences between replicates for all sessions are automatically displayed. This table must be constructed according to the number of sessions, of panellists. If a difference between 2 repetitions is less than or equal to 3, then the panellist has been repeatable for this attribute and for this session (a "yes" is displayed) (**rule 1**).
- 4- The number and % of yes is calculated automatically. If the % of 'yes' is greater than 50%, then the panellist is repeatable for this attribute (an "OK" is displayed). Attention, this rule must take into account the fact that some panellists do not participate in all sessions (panellists 5 and 8).
- 5- Apply these instructions for all other sensory attributes.
- 6- In the **Summary on repeatability** tab, copy and paste in the corresponding columns (B, C, D...) the last column of the previous **Repl-xxxx** tabs (here X) summarizing the performance in terms of repeatability of all panellists.
  - Columns (G and H) specify the % of times that the panellist was not repeatable for all attributes.
  - If this % is strictly higher than 50%, then it is displayed as "panellist not repeatable at all". All these scores will be eliminated (**rule 3**). This is the case here of panellist N°1.
  - For each attribute, it is displayed if the panellist is repeatable (-) or not (panellist not repeatable for this attribute). In the latter case, all the scores of this panellist for this attribute will be eliminated (**rule 2**).
- 7- In the **Data before cleaning** tab, copy-paste the table from the **Raw data** tab. Locate the non-repeatable panellists for all attributes (here panellist 1) or some attributes (for example panellists 4 and 12 for firmness). When the panellist is not repeatable for a product in a session (this is visible in the synthesis table for each attribute), the data for that attribute and for that product are also deleted (e.g. for firmness, the data for panellist 2 is deleted for the products De J0 and Fhi J4 and the data for panellist 5 for the product Fhi J4). All data not previously validated are marked in red and are then actually deleted in the **Data after cleaning** tab.

*Recommendations: In the example, we have deleted the data of panellist 1. The facilitator will occasionally have to inform him/her of these counter-performances and possibly re-train him/her for future sensory analysis. For the other panellists, the facilitator should alert them to their underperformance for a particular attribute (for example, panellists 4 and 12 are not repeatable for the Firmness attribute).*

## 2.3 Evaluating the panellist's agreement with the panel and prepare the data

In order to optimise the agreement of the panellists with the panel, we have set ourselves two rules:

- **The agreement is effective if the difference (in absolute value) for a given product between the average score of the panel and that of each panellist is less than or equal to 3 on a scale of 0 to 10.**
- **If, for an attribute, more than 50% of a panelist's data does not agree with the panel, then that panellist's data for that attribute are discarded.**
- **If the panellist is not in agreement with the rest of the panel for more than 50% of the attributes, then the panellist is removed.**

NB: we propose here a simpler rule than for the evaluation of the panel's performance during training sessions (RTBfoods\_E.2.2\_2018.pdf, p33) where we had set a deviation of 70% from the standard deviation of the panel. L'objectif est d'avoir au moins 8 panélistes en accord avec le panel pour chaque produit à la fin de la préparation des données.

- 1- In the **Agreement with panel** tab, copy-paste the data from the **Data after cleaning** tab. Insert a row per product to display the means by sensory attribute.
- 2- For each product and each attribute, the difference in absolute value between the panel mean and the panellist score is automatically displayed (columns M to Q). All missing data ("not applicable") and data greater than 3 are displayed in red (use the Conditional Formatting command in the Excel menu).
- 3- Highlight (in orange here) in the initial data (columns F to J) the scores associated with the cells in red (columns M to Q).
- 4- In the **Summary on agreement** tab, copy and paste (value and format) the columns A (panellists) and M to Q (attribute deviation) from the **Agreement with panel** tab. Sort by panellist. Display for each panellist the number of times he or she has disagreed with the panel, i.e. when the values are greater than 3. Some boxes are displayed "not repeatable".

*Recommendations: In the example, panellist 13 was in least agreement with the panel for the attribute's mealiness (4) but this remains acceptable on the number of products analysed (12). However, the facilitator should review the data from this panellist and discuss with him/her again the understanding of the use of the scale and the need for further training for future analyses.*

In our example, at least 8 panellists have been selected for the final evaluation of each product. However, for some "product x sensory attribute" combinations, the number of panellists was 7 (for example, for product n°405, only 7 panellists were selected to evaluate mealiness, stickiness and sweetness). This is reasonable and inconsequential for data processing.

## 2.4 Prepare the final tables

The final mean table displays the average values obtained by the panel for each product, each attribute on a scale of 0 to 10. For attributes evaluated on a bimodal scale (yes / no), the average score corresponds to a frequency of "yes" on a scale of 0 to 10.

- 1- In the **data\_mean** tab, copy and paste the data from the **Agreement with panel** (by removing orange data). For the attributes evaluated on a binomial scale (here sourness and astringency), a frequency of "yes" is calculated and then brought back to a scale from 0 to 10 to be able to compare these attributes with the other attributes evaluated on a scale from 0 to 10.
- 2- In the **mean per product** tab, copy and paste the data from the **data\_mean** tab, display the name of the products in front of the Mean line, then delete the panellists' lines.

**This table is the one that will be used afterwards for all graphical (radar) and statistical analysis (PCA, linear regressions).**

In the ***Final data*** tab, copy and paste the previous data from ***data\_mean*** and delete all the mean values and intermediate headers. **This table is the final table cleaned of all data which are not repeatable and not in agreement with the panel.**

In conclusion, monitoring panel performance is an important step in the analysis of your data. It allows you to eliminate poor performers or unacceptable data. This ultimately allows you to prepare your data for statistical analysis.

A future tutorial will be provided on statistical analysis of sensory data, including Principal Component Analysis (PCA) and linear regression (single and multiple) to relate your sensory attributes to physical-chemical data.

## 3 APPENDICES

### 3.1 Annex 1:

Excel file - Example: One replicate per session in « [RTBfoods F.2.4 Tutorial for Performance Monitoring Sensory Data Cleaning Before Statistical Analysis Annex1 2021.xls](#) »

### 3.2 Annex 2:

Excel file - Example: All products replicated in « [RTBfoods F.2.4 Tutorial for Performance Monitoring Sensory Data Cleaning Before Statistical Analysis Annex2 2021.xls](#) »



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