RTBfoods Step 4: Consumer Testing in Rural and Urban Areas

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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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1. STEP 4 OBJECTIVE

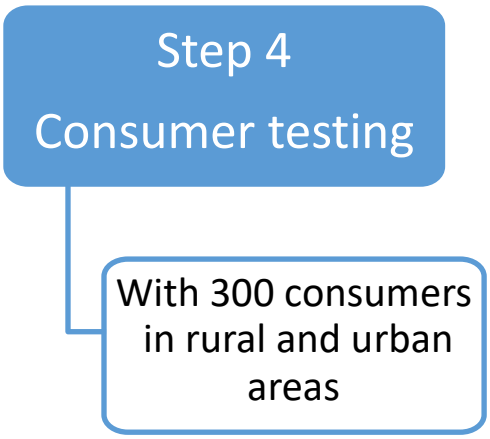
The objective of this Step 4 is to understand the consumers' demand for quality characteristics of the product under study, i.e. to understand what a high quality product is for local consumers.

The sensory characteristics of several products that have very different sensory properties will be related to the overall liking with a large number of consumers.

The products will be made from local varieties and/or genotypes that were selected by processors and research team because of their different quality characteristics (in Step 3).

Consumer testing will be conducted in rural and urban areas previously identified in Steps 2 and 3.

2. STEP 4 OVERVIEW



A Food scientist led-team will undertake consumer testing in the same sample areas as Step 2 and 4. The consumer testing will use the information from the previous steps (e.g. the quality characteristics including product variations, the users' demand, socio-economic and gender background), to better understand relationships between sensory characteristics and consumer overall liking.

For sampling, it is envisaged that 300 consumers will be interviewed in total (i.e. 120 in a rural area, and 180 in an urban area, out of which 60 will be interviewed in small towns, and 120 in cities). Previous activities will inform the sample locations where consumers are able and comfortable to test the products.

This Step 4 will consist of Individual Interviews with Consumers (IIC) where consumers are invited firstly to fill a small questionnaire on demographic information and consumption habits. They will then be asked to taste each product, one after the other, in a specific random order, and score the overall liking using a nine-point hedonic scale (1. "Extremely dislike, 9. "Extremely like"). They will also be asked to score the intensity of 2-4 specific characteristics identified as important in Steps 2 and 3, using the 3-point JAR "Just About Right" scale (1 = TS "Too weak", 2 = JAR "Just About Right", and 3 = TS "Too Strong"), and to describe the product using a CATA "Check-All-That-Apply" table including sensory and perception characteristics collected during Steps 2 and 3 (Refer to Appendix A: Summary of the Quality characteristics of the final product collected during Steps 2 and 3. Finally, they will be invited to give their views about the product.

3. EXPECTED OUTPUT

The output from Step 4 is a report on **Consumer Demand and Preferences** of the product in rural and urban areas.

The report will include:

1. An inventory of consumption habits (frequency of consuming the product, how, with what, when, where)
2. A mean overall liking score for each of the products, in global or in the different rural and urban areas. Overall liking scores will be related to gender and socio-economic background.

3. A segmentation of consumers into groups of similar acceptance patterns regarding the products using a Hierarchical Cluster Analysis (Wards Method), including relationship with gender and socioeconomic background of consumers (age, education…).
4. A determination of the optimum level of intensity for some sensory characteristics of products by using a JAR scale. These specific characteristics were identified as important in Step 2. The assessment of such characteristics may help to understand why consumers like or dislike this product.
5. A sensory mapping of the products: relationship between frequencies of citation of sensory and perception characteristics (CATA table) and hedonic overall liking scores for each product.
6. A description of consumers' opinion and preferences on the products.

The Coordination team will provide a template for reporting, including:

- Main report with headings and sub-headings that highlight essential data.
- Examples of tables, graphs, with the different types of analyses are provided in Appendix H.

4. GUIDANCE

4.1. Choice of the products to be tested by the consumers

- The **number of products** to be proposed to each interviewed consumer must be limited to **4 or 5**. If the number is higher, the consumer may become tired and the test may be unreliable.
- The products proposed to consumers to be tested should be quite **different in their sensory characteristics**, which will help to understand what characteristics of the product meet consumer demand.
- These products will be **processed during Step 3** in a large enough quantity to be tasted by a large number of consumers (300).
    - The 4-5 products tested here are made by a group of processors in Step 3. These processors are in a small town (or processing centre), all using probably the same process. The variation in the process will be observed (or not) in a second small town from the same region, or in the two other small towns in the second region.
    - Each product tested by each consumer should be provided from the same batch of production (for statistical analysis).
    - Calculate the quantity required (in one batch) for consumer testing (Step 4). The product may be tested raw, cooked into paste, or boiled.
    - The consumption pattern chosen for Step 4 will be defined in Step 2, as the most frequent consumption pattern of the product. The quantity of product needed for one test is around 30-50 g per consumer.
    - If the product is consumed cooked or with water added, confirm with processors the ratio product/water to calculate the quantity of the raw product you need to produce with processors during processing diagnosis, and then the quantity of "ready to eat" product for consumer testing (Step 4).
    - The 4-5 products tested by the consumers will be presented to each consumer in the form with which they are usually most consumed. For instance, gari may be tested raw, or with water added, or cooked into a paste, or other form. The consumption pattern is chosen because it is the most frequent that was identified during surveys in Step 2. However, it must be practical enough to transport the products in the town for meeting consumers. The important point is that: by eating the products under that form (raw, with added water, as a paste for instance), the consumers must be able to perceive differences between products and be able to score their overall liking.

- To increase the variability of sensory properties between products, you may:
    - Ask processors (in Step 3) to process new genotypes that are very different compared to local varieties and will probably result in products with very different quality characteristics
    - Ask processors (in Step 3) to alter one or several steps in the process in order to purposely obtain (or cause) a lower quality
    - Buy other products in a market, coming from different regions or countries with very different sensory characteristics
- The 4-5 products must have a large variability of sensory characteristics to be perceived very differently by the consumers, when they will look at, touch, smell, or taste each of the products. Thus, we will be able to better understand what are the most liked and least liked sensory characteristics for a consumer. All the data in Step 4 will be analysed by gender, region, and ethnicity.
- The objective here is not to compare new genotypes and local varieties regarding their sensory profile.
- **The objective is to create a large variability of products to invite consumers to tell us what their sensory preferences are and what they are not, which is easier for people to articulate when products have large differences between them.**

4.2. Development of the questionnaire

- The questionnaire will start with personal information (Gender, Region/country of origin, Nationality, Country of Residence, Ethnic group, Age, Education, Occupation, Marital Status, Wealth status) and consumption habits of the product (frequency, way of consumption, accompanied with what, when, where). Refer to Appendices B & C: Consumer Testing Questionnaire – Part 1 & Part 2.
    - Relevant questions depending on the product and the country should be proposed, based on the information obtained during Steps 2 and 3. You need to adapt the questions to the [product under study] in your country.
- The questionnaire will continue with 3 successive tests :
    - A hedonic test to score the overall liking of the product by each consumer using a nine-point hedonic scale (1. “Extremely dislike to 9. “Extremely like”). Refer to Appendix D: Consumer Testing Questionnaire – Part 3.
    - A JAR test on 2-4 important characteristics to understand if, for that characteristic the product is as the consumer likes, or stronger, or weaker. A 3-point JAR “Just About Right” scale (1 = TS “Too weak”, 2 = JAR “Just About Right”, and 3 = TS “Too Strong”) will be used. Refer to Appendix E: Consumer Testing Questionnaire – Part 4.
    - A CATA table with a list (20-25) of sensory & perception characteristics (most liked or least liked, mainly sensory characteristics) collected during Steps 2 & 3: the consumer is invited to put a tick/mark in front of the appropriate quality characteristics to better describe each product. Refer to Appendix F: Consumer Testing Questionnaire – Part 5.
- In the last part of the questionnaire, the consumer is invited to give his/her opinion on the product and his/her preferences, by asking which product looks more like the one he/she usually consumes, which product he/she dislikes the most, which he/she likes the most and why. Refer to Appendix G: Consumer Testing Questionnaire – Part 6.
- Before printing, you need to :
    - Number each questionnaire to avoid errors if there are several enumerators, when entering the data in the Excel file.
    - Code the samples with 3-figure codes generated using random function: rand() in Excel. Each sample will have a unique code.
    - Randomise the order of presentation of the products on the questionnaire to avoid that the analysis may be biased if samples are presented in the same order to the consumer.

    - Randomise the order of the CATA sensory & perception characteristics in the CATA table in order to limit bias when the consumer will describe the product by choosing the terms in the table, while tasting.
- Print enough questionnaires before leaving for the field.

4.3. Sampling

- It is important to ensure that **equal numbers** of **female and male consumers** participate to the consumer testing.
- Among interviewed consumers, equal number of main ethnic groups and balanced sampling for ages are also important to consider, particularly if certain factors such as these were found to be important in Step 2.
- Only **consumers** who are **used to consume regularly** the product under study will be invited to participate in the consumer testing. He/her should be able to describe the product by choosing appropriate terms (CATA characteristics in the CATA Table), and be able to perceive the intensity (JAR or TS or TW) of some specific characteristics related to the product.
- For **rural area**, two regions, **one rural area per region**, with **four villages in each area** will be chosen. **In each village**, a minimum of **15 consumers** is envisaged to participate in the consumer testing. In total, 60 consumers per rural area, i.e. **120 consumers for the two rural areas**.
- In the secondary centres (small towns), it is envisaged that 15 consumers will participate in the consumer testing in two locations of one small town, i.e. 30 consumers in one small town, based on consumer groups, e.g. wealth or ethnicity. If there are 2 regions covered by the study, then it would be advised to select **one small town per region (Figure 1)**, and to conduct **30 interviews in each small town, in two locations (15 consumers per location)**, i.e. **60 interviews** for the two small towns. If **two small towns per region (Figure 2)**, 4 small towns, (15 consumers in each small town), 60 consumers in total.
- For **urban area**, select one major city to conduct consumer testing in **4 different locations** in the city, for **a total of 120 consumers** (**30 consumers per location**), or better **8 different locations** in the city, for **a total of 120 consumers** (**15 consumers per location**).
- Marketing interviews, using the guidance provided in Step 2, should also be conducted in urban areas during this phase. The Market Interview questionnaire provided in Step 2 will need to be tailored to people who market at an urban level, including retailers, semi-wholesalers, and wholesalers.

4.4. Choice of locations

- Choose a place where it is easy to recruit unknown consumers to invite them to take time to taste products and answer a questionnaire. Explain to them that it will take about 30-45 min to go through the testing (this time will be evaluated during pre-testing sessions).
    - A large number of people should frequent the place and so they may be asked to participate in the consumer test.
    - These members of the population recruited for participating in the test should be **regular consumers** of the product to better assess the characteristics and give their opinion. They must be **over 18 years old**.
    - The place may be the terrace of a restaurant, of a tea room, of a bar, the front of a shop at the market, etc. Please try to find variation among these locations to reach individuals of different socio-economic status, ethnicity, etc.
    - You need to negotiate with the owner to use (or bring) several tables and chairs, one for the preparation of each product sample in plates or glasses, previously coded with a marker, and 2-3 others for consumers to sit comfortably near the enumerator (and translator) for tasting each product, one after the other.
    - Avoid showing the product samples to consumers before the consumer test.

- Each consumer should participate in the consumer test **separately** from other consumers: one table for one consumer and one enumerator (and one translator)

- Consumers should have various age, education, position, gender, socio-economic background to have a large variability of population giving their view on the products.
  - The sample should include equal numbers of men and women.

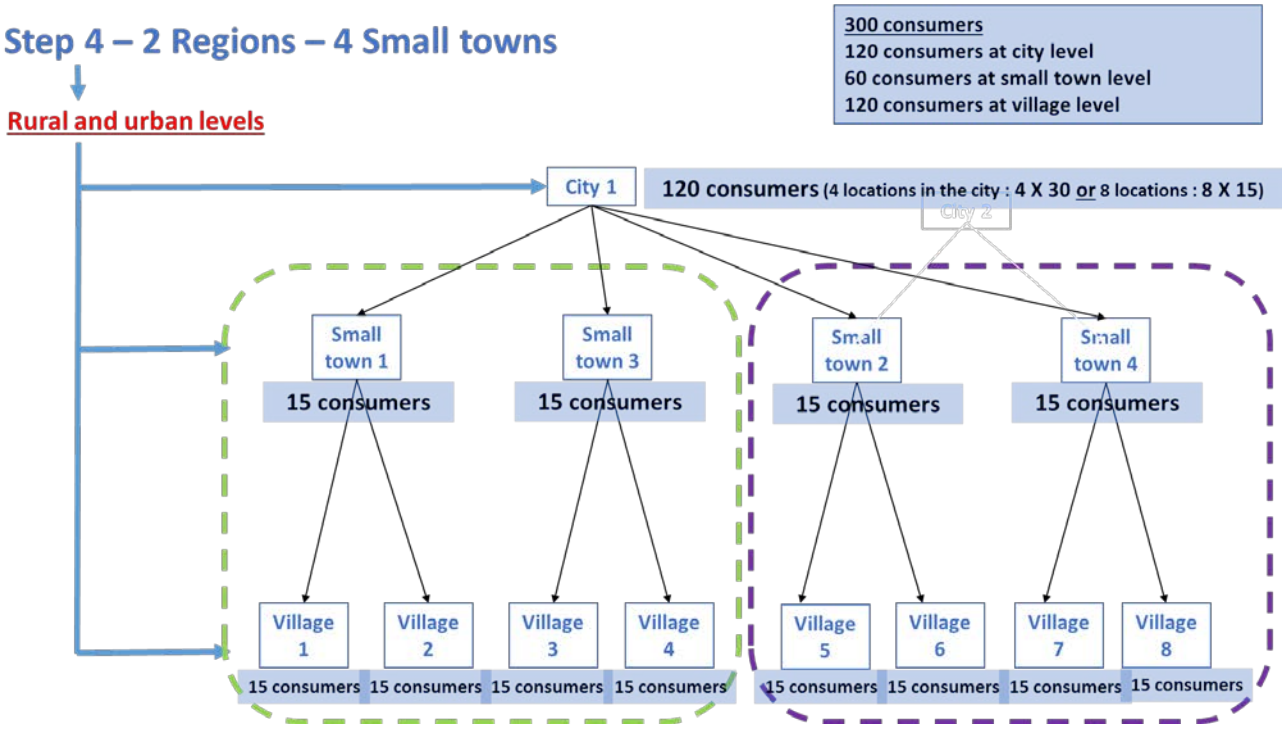


Figure 1: Step 4 sampling in two regions, 2 small towns per region

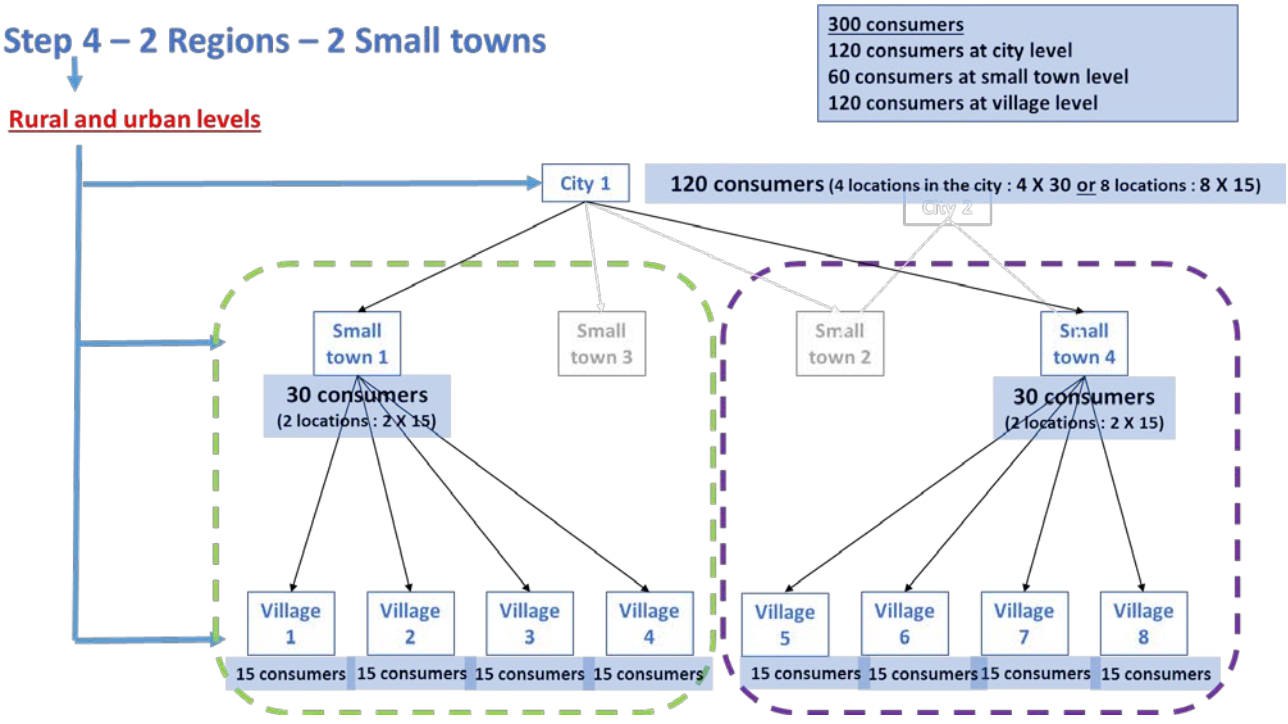


Figure 2: Step 4 sampling in two regions, one small town per region

Table 1: Consumer study sampling for Step 4

Total Number	Explanation
• 120 consumers in 8 villages, 2 regions, 4 villages per region previously visited (60 consumers in each region, 15 consumers per village).	• Purposively select in each region 1 primary city for the consumer tests, in addition to 2 small towns/secondary centres with 1 processing centre in each, and 4 villages visited previously in the other Steps. • Randomly recruit members in the population, one after the other, to participate in the consumer testing separately. • They should be regular consumers of the product to better assess the characteristics and give their opinion. They must be over 18 years old. • It is important to ensure that equal numbers of female and male consumers participate in the consumer test. • Choose a place where it is easy to recruit consumers to invite them to take time to taste products and answer a questionnaire. Explain to them that it will take approximately 45 min to go through the testing (this time will be evaluated during pre-testing sessions). • Consumers should have various age, education, position, gender, socio-economic background to have a large variability of population giving their view on the products.
• 60 consumers in 2 small towns/secondary centres previously visited, 2 regions. If one small town per region (30 consumers or 15 consumers in 2 locations in each small town). If two small towns per region, 4 small towns, (15 consumers in each small town).	
• 120 consumers in 1 primary city (30 consumers in 4 different locations of the city, or better 15 consumers in 8 different locations of the city).	
• 4 Market Interviews (MI). If a larger sample can be covered, then 10-15 wholesalers and 30 retailers should be covered in cities.	• Purposively select – e.g. leader of a wholesale trader association or market management that deals with the crop/product. • Where possible, try to interview equal numbers of men and women.

Table 2: Sampling criteria for villages, small towns (secondary centres), and cities

	Village	Small town / secondary centre	City
Population	< 5,000	~ 10,000 – 100,000	> 500,000
Other indicators			
Processing centre (for selected product, e.g. gari)	No Only a bit of village processing of product	Yes, mostly small and medium enterprises (SMEs)	Possibly, including SMEs and large-scale industries
Other industries	No	Some SMEs (e.g. carpentry workshop)	SMEs and large-scale industries
Existence of markets	Small, and only on a weekly basis Perhaps one or two traders live in village who aggregate produce	Permanent medium or large-sized market, not only along roadside but also in designated market area	Likely to have several markets, both small and large (for retail and wholesale traders)
Other infrastructure	Perhaps primary school, and small church or mosque	May have hospital or health centre; secondary school, church, mosque	Likely to have hospitals, secondary schools, university, churches, mosques

4.5. Preparation of the products

- The products must be provided from a same batch of processing.
- If the product is consumed more frequently cooked (this will be determined during Steps 2 & 3), you should ask the same women to cook the products at the same time, in the same way, to avoid the effect of the cooking on the quality of the products (mainly when you would like to compare new genotypes and local varieties). In that case, the products must be kept at constant temperature (e.g in a thermos) for consumers to assess well some characteristics such as consistency of the product, colour, aspect of the surface ... particularly dependent on the temperature and cooking conditions.
- If the product is tasted with added water, please buy bottles of water, and ask the consumer to add water into a transparent plastic glass containing the product, at the same level (same volume -- put a line on the glass with a marker).
- The product must be prepared in the same way every day (repeatability of the process) to ensure that product is the same.
- Products should be tested around the same time after cooking or after adding water, so their characteristics (texture, aspect) will be the same for the consumers every day.

- Each product must be tested in the **order given by the questionnaire** (order of presentation randomised), one after the other, until the 4-5 products will be tested.
- Consumer should perform all the tests in the questionnaire on one product, before going to the second product, and so on. All the tests will be applied on the other products.

4.6. Utensils needed

- Cups or glasses and drinkable water (consumers to rinse mouth between products)
- Location and culturally appropriate product serving/consumption items (e.g. bowls, plate)
- Markers to identify the product on the plate or glass, or bowl (3 figure-code)
- Napkin
- Bin (waste disposal)
- Tables and chairs to sit for 2 to 5 consumers (depending of the number of enumerators involved), and a table to prepare samples
- Laptops for data entry if possible

4.7. Team

- Team leader: a food scientist.
- Gender specialist and economist can contribute their expertise to review of the questionnaire, being mindful of time constraints. While they may be asked to assist with the consumer tests, their roles can be mainly to:
    - Gender specialist/economist, may want to note and observe behaviours of respondents – there may be interesting observations to make about the type of people who will approach the consumer test, how they respond, etc.
    - Economists to conduct an adapted Step 2 questionnaire for urban retailers, semi-wholesalers, wholesalers. These will be in locations where urban-level retailers will be found and not necessarily in the same locations or times of the consuming testing.
- Enumerators (5-10): food science students (masters or PhD students) who are familiar with sensory evaluation and consumer testing.
- Each enumerator should sit next to the consumer at the same table, to explain to him/her the consent process and each step of the product testing process in the local language, but without influencing his/her judgment or scoring. A translator may help when needed.
- Each enumerator should explain and translate the questions on the questionnaire clearly and translate consumers' answers. In some cases, the hedonic scale has to be adapted to language.
- Data entry people (2-3) if possible: can enter data from the questionnaire into Excel.

4.8. Pre-testing the questionnaire with small sample of consumers (5-10 people)

- The questionnaire should be pre-tested with a few consumers (5-10) for testing the logistics.
- The pre-test is also useful to train the enumerators (students in food science) and translators in accompanying the consumer in understanding the different tests and give their view on the product.
- Choose a convenient location, different from the location for the real testing.
- Refine the questionnaire if necessary.

4.9. Consumer testing

- Same as pre-testing but at larger scale.
- Organise transport for enumerators and translators.

- Organise transport & logistics for products.
- Don’t forget water and ‘gifts’ for the participants if possible: e.g. buy a soda, or sweets.
- Basic information about the project should be given to consumers and they will be asked to sign a consent form. Use the RTBfoods Consent forms for consumer testing (to be supplied).
- A template of the consumer questionnaire is provided (Appendices A to G).
- Please keep in mind that for the RTBfoods project it is important that we have comparability of the data between countries and products.

4.10. Data analysis

- Transfer the data reported in the questionnaires to a computer (Excel – requires data entry people)
- Analyse the data using appropriate statistical analysis (XLstat)
- A template for data analysis and for reporting will be sent to each partner.

5. APPENDICES

Appendix A: Summary of the Quality characteristics of the final product (collected during Steps 2 and 3)

	Quality characteristics of the final product		
	Raw Final product	**Cooked ready to eat final product**	**Cooked ready to eat final product**
	When buying	In the plate	In the mouth
List of the most liked characteristics	Appearance Odour Texture between fingers	Appearance Odour Texture between fingers	Taste Aroma Texture in mouth Aftertaste
List of the least liked characteristics	Appearance Odour Texture between fingers	Appearance Odour Texture between fingers	Taste Aroma Texture in mouth Aftertaste

Appendix B: Consumer Testing Questionnaire – Part 1: Initial information

Date: Investigator name: Questionnaire number:

Name of village/town/city:

Consumer testing of [product under study], country

Gender: ☐ F ☐ M

Region and country of origin:

Nationality: **Other:**

Country of residence: **Other**:

Ethnic group [pre-code]:

Age (years)**/age range** (if age unknown)**:**

Occupation (formal or informal)**:**

Marital status:

☐ Single ☐ Married ☐ Widow(er) ☐ Living with parents/elders

Wealth status:

Country-specific – use census or government categories if possible, or categories that the public is able to refer to. Another option is using the Progress out of Poverty Index, which is available online.

Appendix C: Consumer testing Questionnaire – Part 2: Consumption habits of the respondent

How often do you consume [Product under study]? *(Tick one exclusively)*

- ☐ Every day
- ☐ Several times a week
- ☐ Once a week
- ☐ Several times a month
- ☐ Once a month

How do you consume [Product under study]?

(Tick one or more if necessary. Precise the order of frequency: 1, 2, 3, …: 1 represents the most frequent)

	Frequency
☐ Dry	
☐ Added with water	
☐ Added with water and ingredients (sugar, peanut, coconut…)	
☐ Sprinkled on beans	
☐ Cooked into eba	

At what occasion do you consume the most frequent form?

(Tick one or more if necessary. Precise the order of frequency: 1, 2, 3, …: 1 represents the most frequent)

	Frequency
☐ Breakfast	
☐ Lunch	
☐ In between meals	
☐ Dinner	
☐	

Relevant questions depending on the [product under study] and the country should be proposed, based on the information obtained during Steps 2 and 3.

You need to adapt the questions to the [product under study] in your country.

Appendix D: Consumer testing Questionnaire – Part 3: Hedonic test

Product tasting

You are now invited to taste the four (or five) products, one after the other, and in the order indicated in the questionnaire

Product n° 642 **Questionnaire number:**

Overall liking

- ☐ 9. Extremely like
- ☐ 8. Like very much
- ☐ 7. Like moderately
- ☐ 6. Like slightly
- ☐ 5. Neither like, nor dislike
- ☐ 4. Dislike slightly
- ☐ 3. Dislike moderately
- ☐ 2. Dislike very much
- ☐ 1. Extremely dislike

Hedonic test using a 9 point-scale

The consumer will look at, touch, smell, and taste the product and give their opinion based on their overall impression.

Each consumer will score his/her overall liking of the product by putting a tick in front of a number according to his/her impression:

9: like extremely; 8: like very much; 7: like moderately; 6: like slightly; 5: neither like nor dislike; 4: dislike slightly; 3: dislike moderately; 2: dislike very much; 1: dislike extremely.

Each product must be tested in the **order given by the questionnaire**, **one after the other**, until the 4-5 products will be tested. The presentation order of each product will be randomised and will be different for each consumer

Consumer should perform **all the tests** in the questionnaire **on one product**, before going to the second product, and so on. All the tests will be applied on each product, one after the other.

Appendix E: Consumer Testing Questionnaire – Part 4: JAR (Just About Right) test

How do you appreciate the <u>Characteristic 1</u> of that product?

Too weak (not enough)	As I like	Too strong (too much)
□	□	□

How do you appreciate the <u>Characteristic 2</u> of that product?

Too weak (not enough)	As I like	Too strong (too much)
□	□	□

How do you appreciate the <u>Characteristic 3</u> of that product?

Too weak (not enough)	As I like	Too strong (too much)
□	□	□

How do you feel the <u>Characteristic 4</u> of that product?

Too weak (not enough)	As I like	Too strong (too much)
□	□	□

Just-About-Right (JAR) test will be conducted on **specific sensory characteristics** (2-4) identified as **important** by the different stakeholders in previous **Steps 2 and 3** (Refer to Appendix A: Summary of the Quality characteristics of the final product collected during Steps 2 and 3).

The JAR test measures the appropriateness of the intensity level of some specific characteristics in the product. Consumers are asked whether a sensory characteristic is as they like, just about right JAR (score 2) or too weak, too low, or not enough (score 1), or too strong, too high, or too much (score 3) compared to what they like.

Just About Right (JAR) test helps understand why people like or dislike the product and inform researchers on what intensity level of some specific sensory characteristics should be changed to increase consumer acceptability of the product.

Appendix F: Consumer Testing Questionnaire – Part 5: CATA (Check-All-That-Apply) test

Example of CATA Table on gari characteristics (previous study in Cameroon, Fliedel et al., 2016).

Sample number:
Tick the quality characteristics* that better describe Gari sample ***(Put one tick in front of one or several characteristics, depending of your choice)***

) Shine	) Dusty	) Coarse	) Brown
) Little sour	) Too hard	) No taste	) Clean
) Sweet	) Fermented odour	) Yellow	) Attractive
) Too acidic	) Bad odour	) White	) Difficult to digest
) Good taste	) Dry	) Elastic	) Good flavour

***** *20-25 sensory characteristics*

◯ Perception characteristics

◯ Sensory characteristics

For Sensory Characteristics Appearance (Coarse, Yellow, White, Brown)

Odour (Fermented odour)

Texture between fingers (Dusty)

Taste (Little sour, Sweet, Too acidic)

Texture in mouth (Dry, Elastic, Too hard)

CATA (Check-All-That-Apply) question

A CATA question consists of a list of terms from which respondents should select those they consider appropriate to describe a product (Ares et al., 2010).

CATA terms can be generated by a panel of trained assessors or by consumers not testing the product (for example in a focus group) (Ares et al., 2010).

The order in which sensory characteristics are placed within a CATA question could be an important source of bias in consumer profiling studies (Ares and Jaeger, 2013).

For our study, Check-All-That-Apply table will include **sensory & perception characteristics** collected during previous **Steps 2 and 3** (Refer to Appendix A: Summary of the Quality characteristics of the final product collected during Steps 2 & 3).

A choice of **20-25 characteristics** is usually advised, because too many terms can result in consumer fatigue. A selection of **most liked and least liked** characteristics is recommended with **a good balance** between them. For sensory characteristics, try to propose quality characteristics often cited during focus group discussions or individual interviews, and regarding the **appearance, odour, texture between fingers, taste, texture in mouth, aroma, aftertaste** of the final product, with **a good balance** between them. Perception characteristics are emotional terms that describe a hedonic impression that cannot be quantified. **It is recommended to limit the number of perception terms (2-3 only),** since sensory terms associated to the overall liking of the products will be very useful for biochemists and breeders to translate these quality characteristics into physico-chemical compounds.

The CATA table with sensory & perception characteristics need to be developed prior to the questionnaire.

A **random ordering** of sensory & perception characteristics in a CATA question is recommended to avoid bias in the total frequency of usage of terms.

During consumer testing, each interviewed consumer is invited to choose the terms in the CATA table that better describe the product, according to their opinion.

Frequencies of citation for each term will be determined by counting the number of consumers that used this word to describe each product. These CATA counts for each characteristic will be used to establish a sensory mapping of the products.

. Ares et al. 2010. Application of a Check-All-That-Apply question to the development of chocolate milk desserts. Journal of Sensory Studies 25, 67–86.

. Ares and Jaeger. 2013. Check-all-that-apply questions: Influence of attribute order on sensory product characterization. Food Quality and Preference 28, 141–153.

. Fliedel G., Monteiro M. J., Tomlins K. I., Maraval I., Bouniol A., Prin L., Adinsi L., Akissoé N., Hanna R., Dufour D. 2016. New approach for better assessing consumer acceptability of improved cassava food products. In : Electronic Proceedings of World Congress on Root and Tuber Crops WCRTC, Nanning 1, Nanning, China, 18/01/2016 to 22/01/2016. http://www.gcp21.org/wcrtc/S20.html

Appendix G: Consumer Testing Questionnaire – Part 6: Give your own opinion

Give your own opinion

If necessary, you can taste all the 5 Product samples again

1. Which Product looks more like the one you usually consume? ……..

2. Which Product do you **dislike** the most? ……

Why?
.....

.....

3. Which Product do you **like** the most? ……

Why? .....

.....

Then the consumer will repeat the same tests on the second product, then on the third, etc., on the other products. Each product must be tested in the order given by the questionnaire (randomised order).

Appendix H: Examples of tables, graphs, diagrams for reporting

Hedonic test: Overall liking of the products

An **Analysis of Variance** (ANOVA) on the mean overall liking scores of each [product on the study] will be performed.

The overall liking of each product was scored from 1 (extremely dislike) to 9 (extremely like).

A Tukey test can be used to analyse the differences between the products with a confidence interval of 95%.

In the example below, significant differences are observed between the three gari products at $p < 0.05$ (n=121 consumers) (from Fliedel et al., 2016).

Each gari product was previously coded with a 3-figure code generated using random function: rand() on Excel.

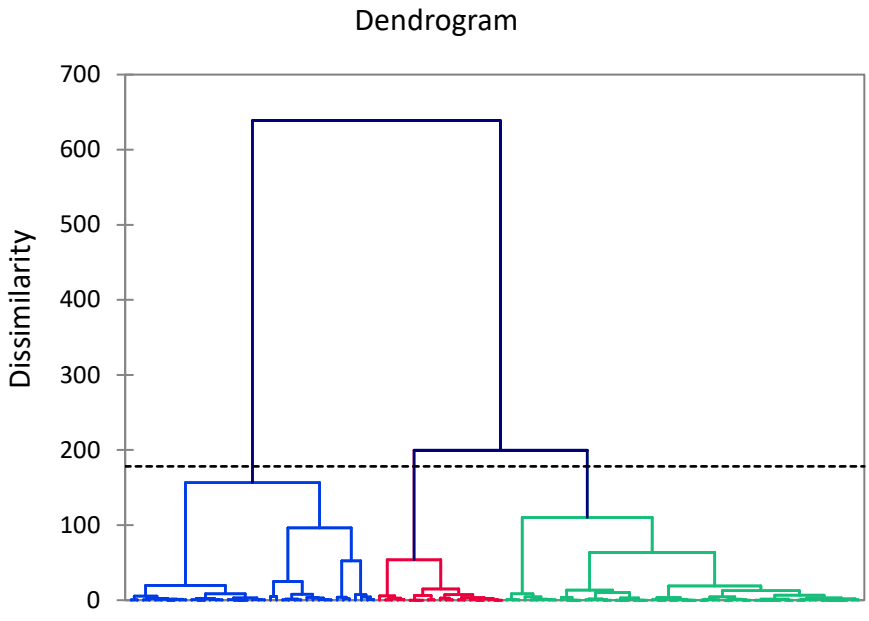
Product	Mean Overall liking	Standard Error	Groups
158	6.72	0.19	A
278	5.94	0.19	B
642	3.66	0.19	C

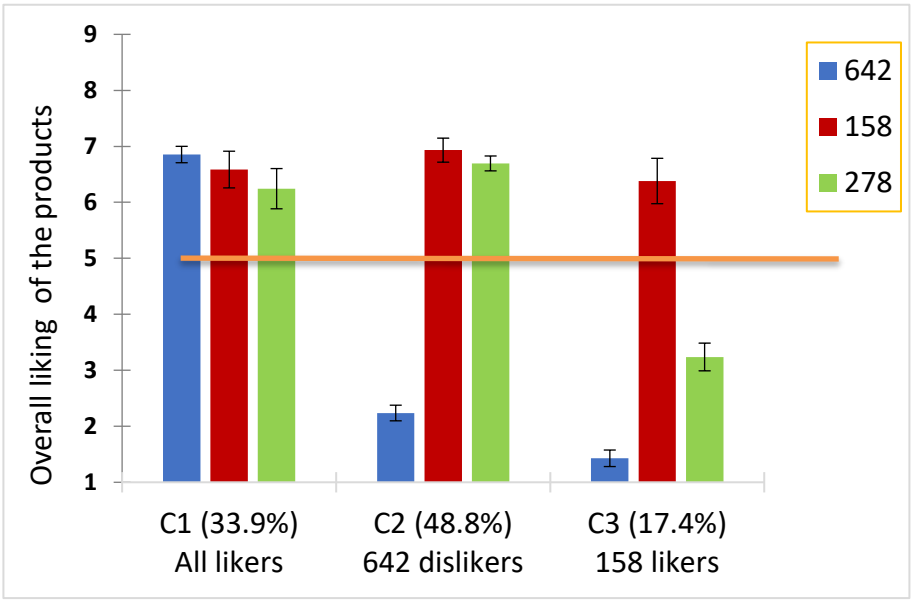
ANOVA can be performed on the whole consumers in the two regions (n=300), or per region, at a city level, at small towns level, village level, per gender, education, occupation or other socio-demographic level.

Segmentation of consumers into groups of similar acceptance patterns

A **Hierarchical Clustering Analysis** (HCA) will be performed on the overall liking scores of the products to have a better knowledge of the consumers who have tested the products. Consumers who had a similar perception of the products will be regrouped in a same cluster.

In our example of three gari products, consumers (n=121) were segmented into three groups (clusters): the first group (C1) that represents 33.9% of the consumers and can be named “all likers” since these consumers have scored the three products over 5 (between 6 “like slightly” and 7 “like moderately”); the second group (C2) that represents 48.8% of the consumers and can be named “642 dislikers” since these consumers have scored the product “642” below 5 (between 2 “dislike very much” and 3 “dislike moderately”); and the third group (C3) that represents 17.4% of the consumers and can be named “158 likers” since these consumers have scored the product “158” over 5 (between 6 “like slightly” and 7 “like moderately”).


Dendrogram
Dissimilarity
700
600
500
400
300
200
100
0


Overall liking of the products
9
8
7
6
5
4
3
2
1
642
158
278
C1 (33.9%)
All likers
C2 (48.8%)
642 dislikers
C3 (17.4%)
158 likers

A Just About Right (JAR) Test for specific characteristics

Consumers were asked to score the intensity of **2-4 specific characteristics** identified as important in **Step 2 & 3,** using the 3-point JAR "Just About Right" scale (1 = TW "Too weak", 2 = JAR "Just About Right" and 3 = TS "Too strong"). The objective is to understand if, for that product, the characteristic is as the consumer likes JAR just about right (score 2), or too weak, too low, or not enough (score 1), or too strong, too high, or too much (score 3) compared to what the consumer likes.

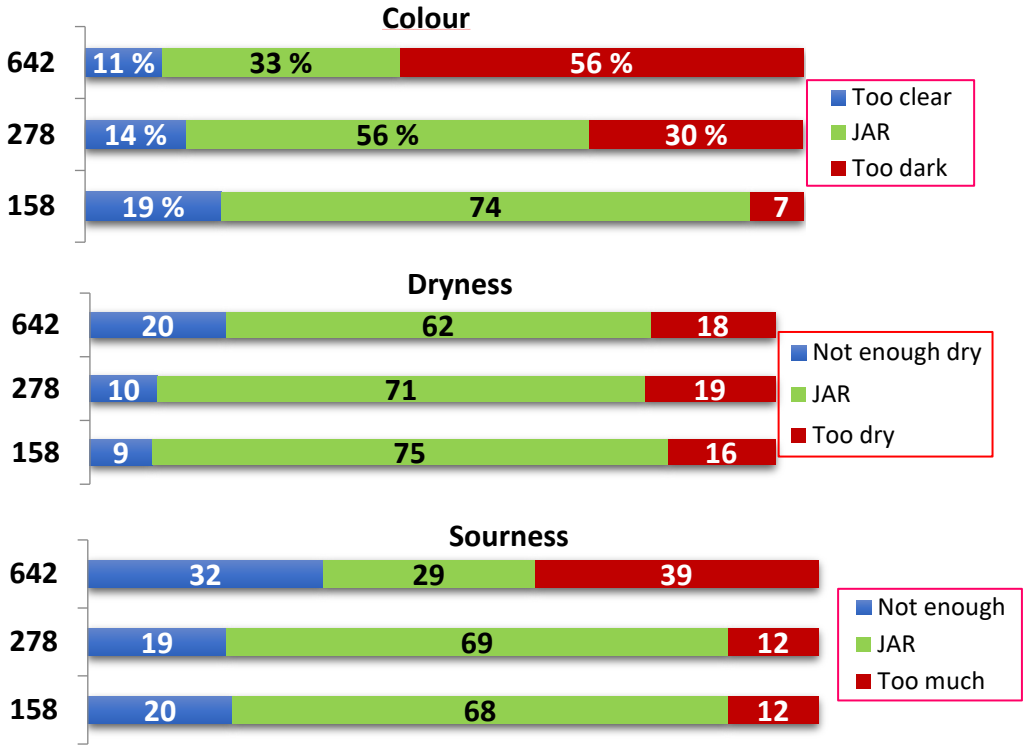
For our example on three gari products, a JAR test was performed on three important **characteristics:** the colour, dryness and sourness (from Fliedel et al., 2016).

For each gari, the number of consumers who have found its colour, then dryness, then sourness, Just All Right (JAR), or Too Weak (TW) or Too Strong (TS) was counted.

Number of consumers who have scored three specific characteristics

Colour			
Products	TW	JAR	TS
642	13	40	68
278	17	68	36
158	23	89	9
Dryness (N)			
Products	TW	JAR	TS
642	24	75	22
278	12	86	23
158	11	91	19
Sourness (N)			
Products	TW	JAR	TS
642	39	35	47
278	23	83	15
158	24	82	15

Percentage of consumers (n = 121) who have scored three specific quality characteristics



Check All That Apply (CATA) Test

Consumers were asked to describe the product using a CATA "Check-All-That-Apply" table including **a list (20-25) of sensory and perceptions characteristics** (most liked or least liked) collected during Steps 2 & 3. The consumer is invited to put a tick/mark in front of the appropriate characteristics to better describe each product.

The number of quality characteristics cited by the consumers was counted for each product (from Fliedel et al., 2016).

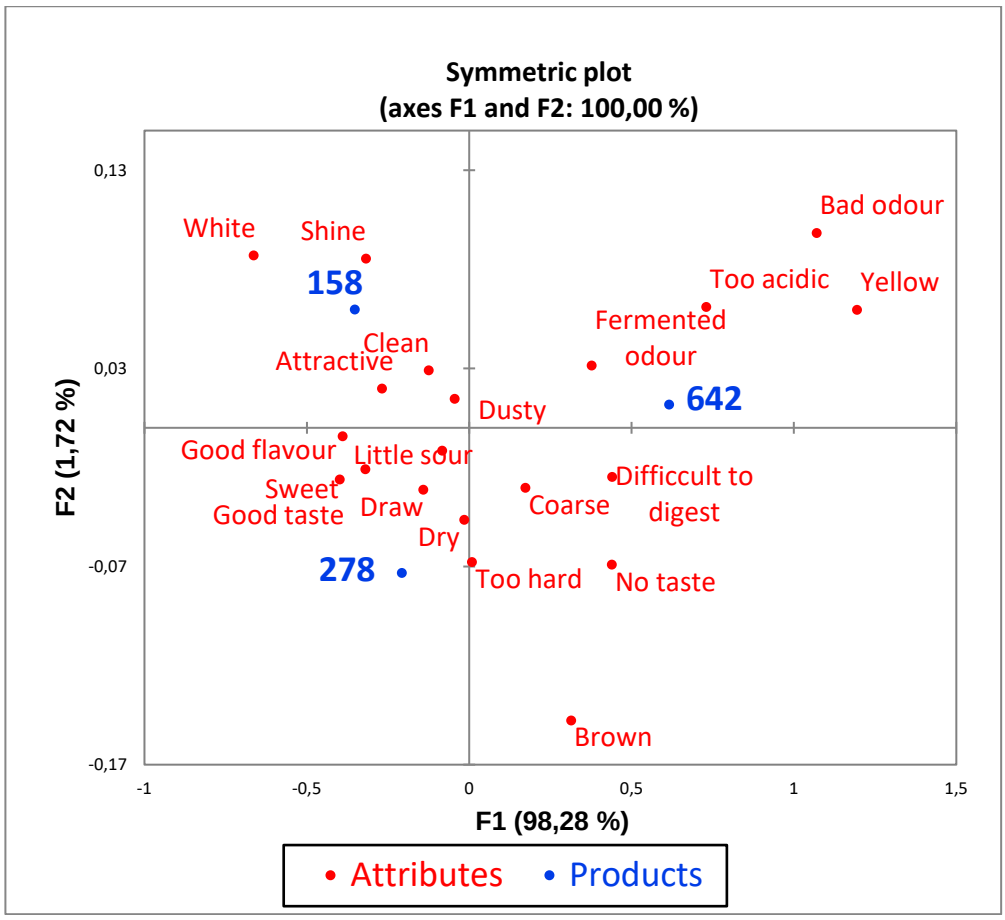
Frequency of citations by consumers (n=121) of each quality characteristic for each product

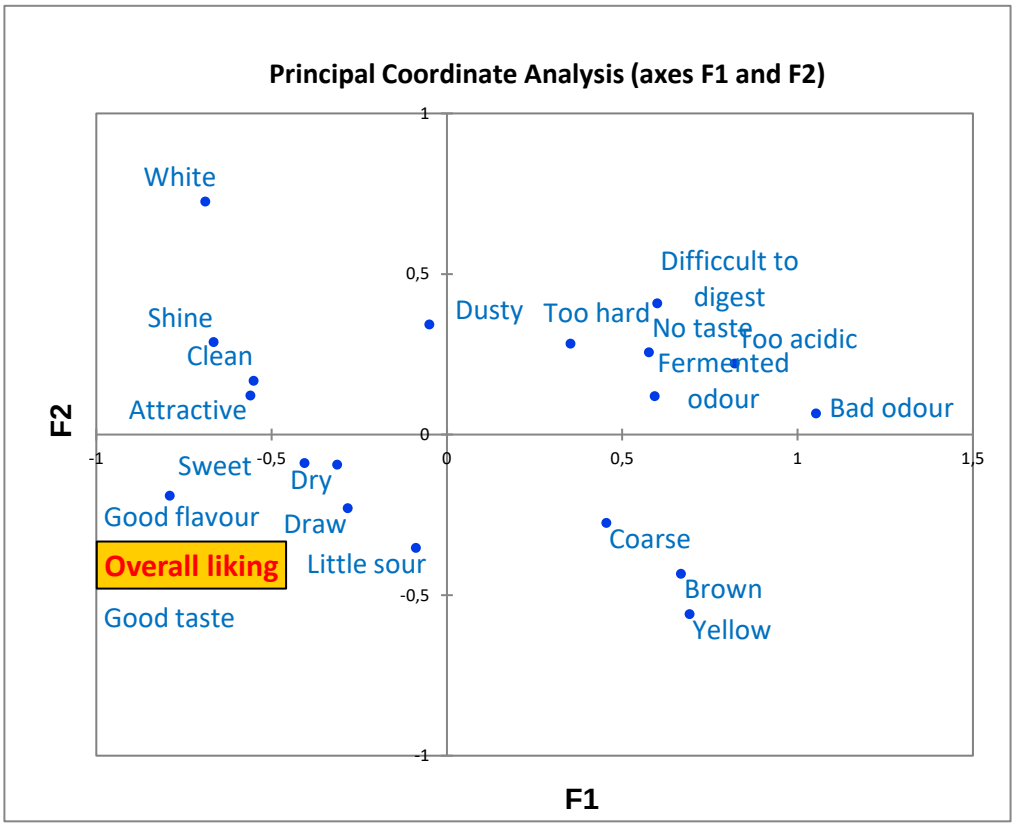
Characteristics	Product 158	Product 278	Product 642
Shine	91	67	33
Little sour	69	66	51
Sweet	45	41	17
Too acidic	11	13	45
Good taste	82	74	23
Dusty	34	31	27
Bad odour	7	11	77
Fermented odour	32	33	62
Too hard	31	35	30
Coarse	54	60	73
No taste	10	15	26
Yellow	2	10	77
White	81	57	2
Draw	51	50	33
Brown	25	43	55
Clean	102	88	66
Attractive	80	68	35
Difficult to digest	24	31	58
Good flavour	83	72	24
Dry	96	102	86

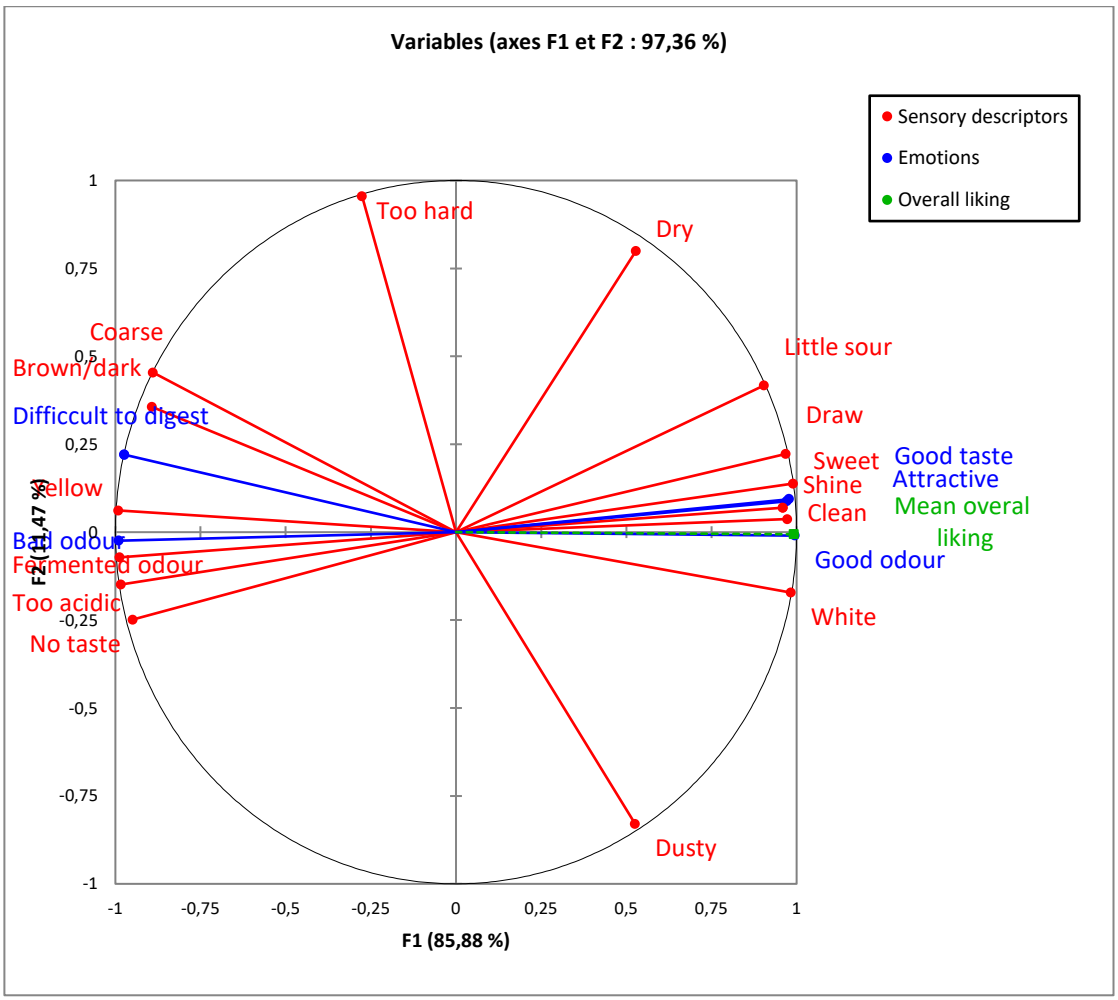
Sensory mapping of the products

Principal component analysis (PCA) will be used to summarise the relationships between the products and the frequencies of citation of the sensory & perception characteristics (CATA table) by the consumers.

A **multi factorial analysis** (MFA) will be used also to show the relationship between frequencies of citation of sensory & perception characteristics and the mean overall liking scores for each product (from Fliedel et al., 2016).


Symmetric plot
(axes F1 and F2: 100,00 %)
0,13
0,03
-0,07
-0,17
-1
-0,5
0
0,5
1
1,5
F2 (1,72 %)
F1 (98,28 %)
White
Shine
158
Clean
Attractive
Dusty
Bad odour
Too acidic
Yellow
Fermented
odour
642
Good flavour
Little sour
Sweet
Good taste
Draw
Dry
278
Too hard
Coarse
Difficcult to
digest
No taste
Brown
Attributes
Products


Principal Coordinate Analysis (axes F1 and F2)
1
0,5
0
-0,5
-1
-1
-0,5
0
0,5
1
1,5
F2
F1
White
Shine
Clean
Attractive
Sweet
Dry
Good flavour
Draw
Overall liking
Little sour
Good taste
Dusty
Too hard
Difficcult to
digest
No taste
Too acidic
Fermented
odour
Bad odour
Coarse
Brown
Yellow


Variables (axes F1 et F2 : 97,36 %)
Sensory descriptors
Emotions
Overall liking
Too hard
Dry
Coarse
Brown/dark
Little sour
Difficcult to digest
Draw
Sweet
Good taste
Shine
Attractive
Clean
Mean overal liking
Bad odour
Good odour
Fermented odour
Too acidic
White
No taste
Dusty
F2 (11,47 %)
F1 (85,88 %)
1
0,75
0,5
0,25
0
-0,25
-0,5
-0,75
-1
-1
-0,75
-0,5
-0,25
0
0,25
0,5
0,75
1

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