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SENSORY ANALYSIS HANDBOOK

2018



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1. SENSORY PERCEPTION

Sensory assessment is the evaluation of signals that a human receives through the senses of sight, hearing, taste, smell, and touch. In a way, sense organs may be viewed as detectors that help to relay information about food properties from external stimuli to the brain (1).

1.1 Physiology of human senses

1.1.1 Vision/Sight

Eyes is the first system of sense organs that we use when assessing the properties and quality of food. An illustration of a human eye is provided in Figure 1. The irritant or stimulus for the eyes is light. The processing of the images begins with the reflection of light from the observed object, as a result of which light passes through the

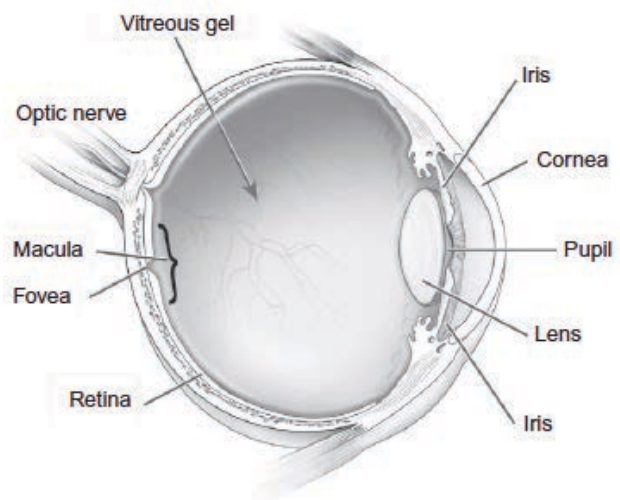


Figure 1. Cross-section of the human eye (2)

cornea to the pupil. From there, light moves to the retina at the back of the

eye where photoreceptors called rods and cones are agitated to convert light into nerve impulses. The rods function when light intensity is weak; cones, on the other hand, are engaged in bright light. The intensity of light striking the retina is regulated by the pupil and its ability to constrict and dilate. (2)

Vision perception is directly tied to other senses. For example, visual perception of food affects recognition of odor and taste, and their intensities. According to specific studies done with wine tasters, the addition of red colorant to white wine significantly increases the use of descriptors characteristic to red wine. (3)

1.1.2 Audition/Hearing

The auditory system is one of the most important human sensory systems as a means of interpersonal communication. Acoustic signals (sound) are the stimuli of auditory system. The system itself is divided into three parts: the outer ear, the middle ear, and the inner ear

(Figure 2). The outer ear consists of the visible part of the pinna (the visible part of the ear) and the auditory canal. The eardrum separates the outer ear from the middle ear. In the middle ear, three small bones are located: the hammer, the anvil, and the stapes. Inside the inner ear is the cochlea which looks like a spiral-shaped canal. The cochlea is divided into three sections, each of which is separated from the other by a membrane and contains a lymphatic fluid. (2)

When the outer part of the ear registers sound waves, they are first directed by the pinna through the auditory canal to the eardrum. The eardrum starts vibrating in turn. The hammer, anvil, and stapes of the middle ear consistently transmit vibrations through the middle ear into the inner ear where the hydraulic movement of fluids in the cochlea changes accordingly. Inside the cochlea on one of the membranes sound-receiving apparatus is located that contains hair cells that transform mechanical vibrations into signals. (2)

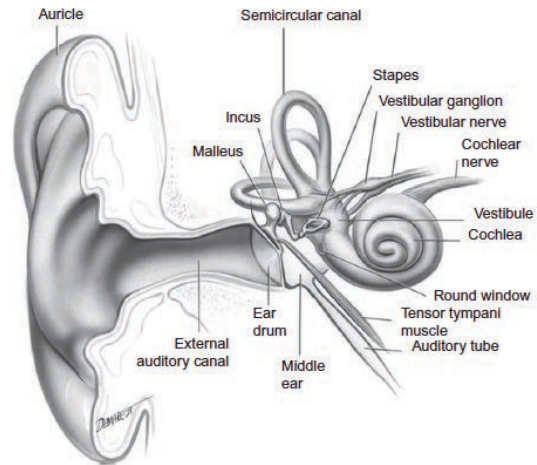


Figure 2. The cross-section of the ear (2)

1.1.3 Somatosensation/Touch

The sense of touch is a complex process of perception of external factors (e.g., mechanical influence, changes in temperature) carried out with the help of receptors located in the skin, muscles, tendons, joints, mucous membranes, and lips. The most common type of tactile receptors are free nerve endings in the surface of the skin (Figure 3). These nerve endings perform a row of different functions of thermoreceptors, pain receptors, and mechanoreceptors.

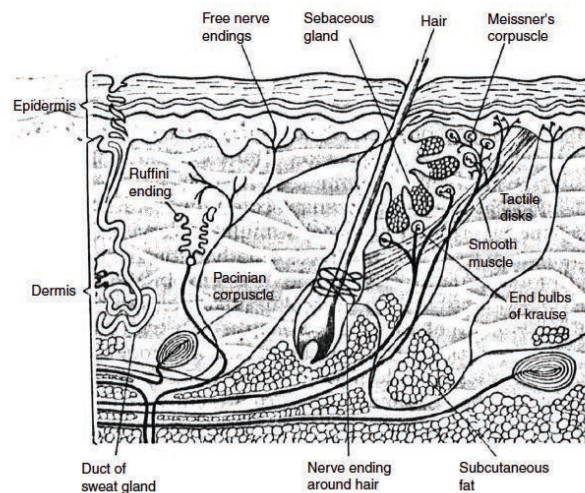


Figure 3. The cross-section of human skin (4)

Mechanoreceptors respond to touch, pressure, stretch, and vibration. The physiological basis of tactile sensation is in agitation of the receptors in the outer layers of the skin, the subsequent agitation of the nerve fibers, and the flow of information from the receptors to the central nervous system. The main receiving channel of tactile information is the spinal cord, through which the signals reach the brain. (4)

1.1.4 Olfaction/Smell

The visible part of human nose consists of nasal bones and cartilage tissue. Before reaching the nasal cavity, the air first enters through the nostrils. The nasal septum, formed by a vertical plate of latticed bone tissue, vomer, and cartilage divides the nasal cavity into two parts. These serve as a humidifier, a heater, and a filter for incoming air. For smell perception to occur, the air containing odor-active molecules must enter the nasal cavity. Odor-active molecules dissolve on contact in the mucus covering the nasal cavity. (2)

10-20 million olfactory sensory neurons are located in a specific small area of the nasal cavity called olfactory epithelium (Figure 4). After dissolving in the mucus, odor compounds attach to the end of the olfactory receptors and interact with the membrane proteins. (5) Membrane proteins involved in olfactory perception are specific to olfactory receptors. There are more than 1000 kinds of receptors where each receptor cell produces one specific type of membrane protein.

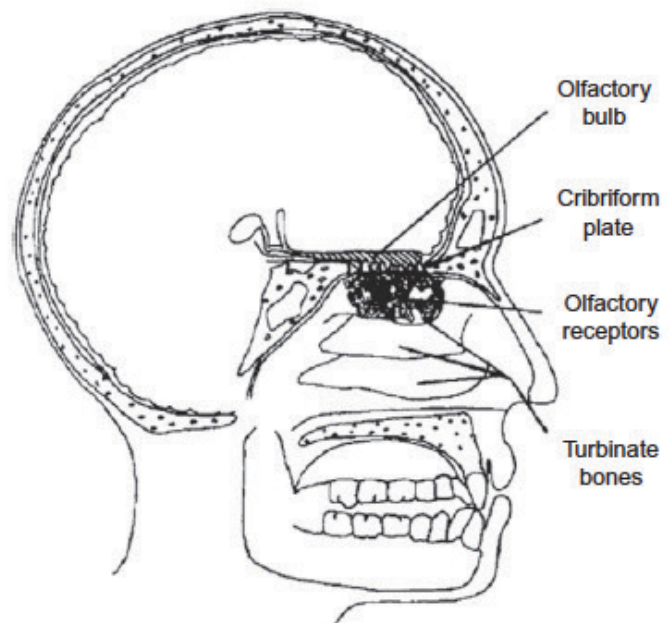


Figure 4. The nasal cavity and olfactory region (2)

Binding of molecules to the receptor proteins is selective, so that each receptor can bind only to a certain range of compounds. Likewise, each odor-active compound can bind only to a certain range of receptors. (2) The sensitivity of the receptors to certain molecules can vary up to 10^{12} times or more (4).

Due to the anatomy of the nose, air reaches the olfactory epithelium only partially. The optimum sniffing time for a full contact is 1-2 seconds. Next comes the adaptation of the

receptors to the smell, after which a pause of 5-20 seconds is recommended to restore the receptors. An additional difficulty hides in the fact that some odorants can partially block the receptors for an extended period of time reducing the ability to detect specific odors or distinguish similar odors. (4)

The sensitivity of the sense of smell varies from person to person and depends on a number of factors such as gender, age, habits, illnesses, and trauma. Cases of complete absence of smell (anosmia) are rare but partial anosmia to certain odor compounds is common. Also, sensitivity can depend on feelings of hunger and satiety, mood, pregnancy, and menstrual cycle. (4)

1.1.5 Gustation/Taste

The oral cavity is the first part of the digestive tract. The entrance to the oral cavity, mouth, consists of the lips, teeth, gums, tongue, and jaw. Inside the oral cavity are mechanoreceptors that respond to pressure, and muscles responsible for the chewing process. Also in the mouth are salivary glands. (6)

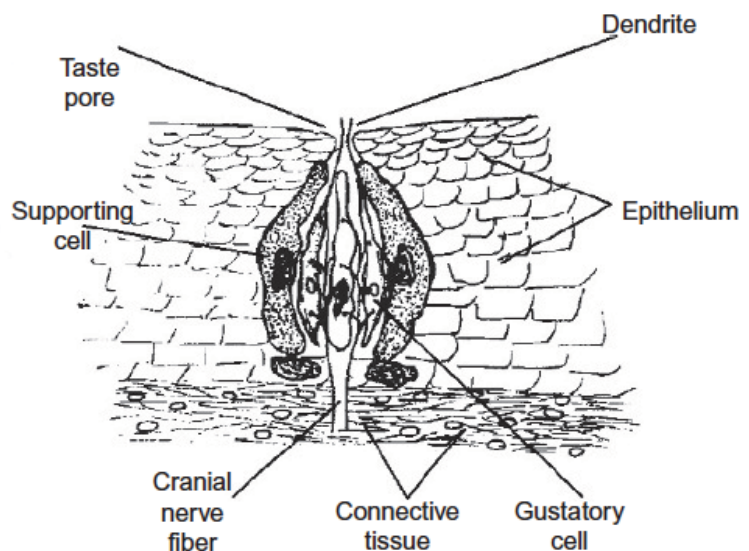


Figure 5. The structure of a taste bud (2)

Tongue plays an important role as it participates in the formation of taste sensation. Taste sensation arises from the presence of hydrophilic molecules soluble in saliva (tastants) that interact with specific receptors in the mouth. The taste cells agglomerate into taste buds which are located both on the surface of the tongue and partially on the epithelium of the palate (Figure 5). (2) One taste bud can contain up to 100 taste cells (7). The average lifespan of a taste bud is 8-12 days. New cells are continuously generated. (2) Each taste bud has a small opening (pore) which is continuously in contact with the environment of the oral cavity. Through this pore, the tastants dissolved in saliva reach the receptors. Receptors themselves are transmembrane proteins that interact either with ions or molecules that cause taste perception. (7)

Five basic tastes can be distinguished: sweet, salty, bitter, sour, and umami. Recent studies indicate that fat could be considered as an additional, sixth basic taste (7). Previously it was believed that the receptors for basic taste are located on the specific parts of the tongue: the tip of the tongue is responsible for the sweet taste; the lateral edges of the front part of the tongue – for the salty taste; the lateral edges of the back of the tongue – for the sour taste; the root of the tongue – for bitter taste. It is now widely recognized that the receptors are distributed uniformly throughout the surface of the tongue (2).

The perception of taste is influenced by several factors such as the concentration of the substances in the saliva, the serving temperature of the food product, duration of stimulus, and the presence of other tastants. A complete lack of sense of taste (ageusia) is very rare but there are differences in sensitivity to certain stimuli. For example, wide variations in sensitivity to different substances causing bitter taste is quite common. (4)

1.2 Sensory attributes

During sensory assessment, sensory attributes are addressed in the following order: appearance → odor/aroma → flavor → texture.

1.2.1 Appearance

The appearance of the food product in or out of the packaging is the main attribute used to make a rapid decision on the quality of the product or its conformity with consumer expectations. Based on that, appearance must be paid detailed attention to when assessing the samples in laboratory environment.

Appearance of a food product can be assessed in terms of shape, size, surface texture, and color (surface and cross section). Additionally for drinks, clarity and carbonations can be viewed. Characteristics of shape and size can include but are not limited to length, width, and thickness; geometric shape (e.g., square, round); distribution of filling or additives (e.g., nuts, dried fruits, vegetables). The surface texture can be dry or moist, smooth or rough, matte or shiny, soft or hard, crispy or chewy. Here, the uniformity of dusting can also be assessed. Color of the food product can be expressed in terms of value, hue, and chroma. The evenness of color can also be included when appearance is in question. (4)

1.2.2 Odor

Odor is defined as a result of a process of volatile compounds travelling during sniffing through the nasal passage into the nasal cavity where they are perceived by the olfactory system. The process of perception of volatile compounds on the olfactory epithelium within the nasal cavity is called the orthonasal olfaction. The number of volatile compounds coming from food products depends on the serving temperature, and the nature of compounds themselves. Surface properties of the food product also play a significant role where the diffusion of volatiles through soft, wet, and porous surface is greater than through a hard, dry, and smooth surface. Some compounds are released as a result of enzymatic reactions (e.g., cutting raw onions or garlic). (4)

1.2.3 Flavor

During oral food processing several processes happen at once to aid perception. For one, mastication of food releases volatile odor compounds that travel through nasopharyngeal passage into the nasal cavity to come in contact with olfactory epithelium (4). This process is called retronasal olfaction. At the same time, tastant compounds in food dissolve in saliva to come in contact with taste receptors packed in taste buds (2). These tastants are perceived as sweet, sour, bitter, salty, or umami. Additional sensations tied to the sensitivity of mucous membranes of the mouth can be caused by certain chemical compounds that stimulate the nerve endings (astringency, metallic taste, spiciness, cooling sensation) (4). The sum of aforementioned perceptions is defined as food flavor.

1.2.4 Texture

The texture can be defined as a manifestation of the mechanical, structural, and surface properties of food products (8). Based on that, texture can be considered as a complex sensory attribute consisting of multiple different simultaneous perceptions.

The primary perception of texture is made through the organs of sight and hearing. Terms that can be used to describe the properties of food in terms of visual perception are surface properties, homogeneity, oiliness, and moistness. Hearing organs are associated with the properties that are manifested through the sounds made when handling or chewing food (e.g., crunchiness). (2)

The sense of touch and pressure is associated with the texture properties that characterize the structure of the food. According to structure, food products can be divided

into liquids, semi-solids, and solids. Unlike liquid products, semi-solids and solids require a lot more mechanical processing in the oral cavity with the help of teeth, tongue, and jaw muscles. (2)

According to *Szczesniak, A.S. (1963)*, texture properties can be divided into three categories: mechanical characteristics, geometrical characteristics, and other characteristics (mainly tied to fat and moisture content) (9). Based on that, Table 1 illustrates a detailed classification of texture descriptors.

Table 1. Texture descriptors according to *Szczesniak, A.S. (1963)* (9)

Mechanical characteristics	<ul style="list-style-type: none"> ● Hardness ● Cohesiveness <ul style="list-style-type: none"> ▪ Brittleness ▪ Chewiness ▪ Guminess ● Viscosity ● Elasticity ● Adhesiveness
Geometrical characteristics	<ul style="list-style-type: none"> ● Particle size ● Particle shape ● Particle orientation
Other characteristics (moisture and fat content)	<ul style="list-style-type: none"> ● Moisture content ● Fat content <ul style="list-style-type: none"> ▪ Oiliness ▪ Greasiness

1.3 Factors affecting sensory perception

1.3.1 Thresholds

Threshold can be defined as a limit to sensory perception. Thresholds are applicable in both odor and taste and are divided into four categories: absolute threshold, recognition threshold, differential threshold, and terminal threshold. Absolute threshold is the lowest concentration of a stimulus (e.g., volatile compound, or tastant) that can be detected. Recognition threshold is the concentration of a stimulus at which the stimulus is recognized and described. Differential threshold is the increase in concentration of stimulus that can be detected. Terminal threshold is the concentration above which a further increase in concentration can no longer be detected. Above this, pain often occurs. (4)

The assessor's threshold is the concentration of any given compound where the sensations caused by the compound are detected 50% of the time. Thresholds, however, cannot be considered a constant and often fluctuate depending on a number of factors. For

example, thresholds can be affected by lack of focus, mood swings, changes in biorhythm, feelings of hunger and satiety, etc. (4)

1.3.2 Physiological factors

First and foremost, overall physical and health condition of panel members should be taken into account. The assessors should be excluded from the session when their health is compromised (e.g., common cold, flu, infections), or they suffer from emotional distress and heavy pressure of work (4).

Smokers should not smoke up to one hour before assessment session. Coffee should also be forbidden up to one hour before analysis. Two hours should pass after a large meal before engaging in sensory assessment. (4)

Other physiological factors at play that might affect panel performance include adaptation; enhancement, synergy or suppression. Adaptation forms as a result of a prolonged exposure to a stimulus where decrease in sensitivity can be observed. Enhancement, synergy or suppression of a stimulus can occur when more than one stimulus are present and interact with each other. As a result of the interaction, one stimulus might be enhanced by the presence of the others (=enhancement); multiple stimuli can be create a sensation greater in intensity than the sum of sensations caused by the stimuli independently (=synergy); one stimulus is suppressed by the presence of others (=suppression). (4, 10)

1.3.3 Psychological factors

The psychological factors that affect sensory assessment by a panel include:

- Expectation error

Expectation errors might occur when too much information about the objectives or samples is given prior or during the analysis. Unnecessary information might trigger certain expectations that indirectly warp panelist's judgement. Instead, samples should be coded and randomized; the amount of information disclosed should be minimal and just enough to fulfil test's objectives. (4, 10)

- Habituation error

When similar samples are presented on a regular basis, habituation error occurs where the panelists feel inclined to assign similar scores irrespective of actual differences that might occur. Habituation error is more common in quality control and can be

avoided by varying samples presented to the panel or by introducing from time to time intentionally altered samples. (4, 10)

- Suggestion and distraction errors

Unnecessary noises or comments made during the analysis might affect focus and, therefore, judgement of the panel. To avoid this error the environment should be quiet and free of distractions; unnecessary banter within the panel should be discouraged; when possible, sensory booths should be used. (4, 10)

- Stimulus and logical errors

When irrelevant properties affect the judgement of the panelists (e.g., color) stimulus error occurs. When the irrelevant properties can also be tied to certain attributes (for example, deeper colored samples are viewed as more intense either in odor or flavor) logical error occurs. To avoid these errors, presented samples should be as uniform as possible or the irrelevant differences masked (colored sniffing glasses, colored lighting, nose clips, etc.). (4, 10)

- Order error

The judgement of one sample can be influenced by the samples that were presented before it. Additionally, the samples that are presented first tend to get higher scores of intensities. To avoid the error, samples can be randomized, additionally balanced, or a “blank” sample of the same product category can be presented first to the panelists. (4, 10)

- Halo effect error

Halo effect error occurs when the perception of one attribute subconsciously affects the perception of others. For example, the sweetest sample can be viewed as the stickiest. The error is the most common in untrained assessors. To avoid the error, it is advised to use a panel of trained assessors. (10)

- Contrast effect error

If the difference between two samples in a line-up is too striking, the panelists might feel inclined to exaggerate those differences. On the other hand, if similar samples are presented in a group of highly different samples, their similarity might be exaggerated. To avoid the error, the order of presentation of the samples can be balanced. Additionally, if possible, samples producing the unnecessary contrast in a line-up should be excluded from the test. (10)

- Central tendency error

When scales are used for assessment to quantify the differences between the samples more often than not panelists tend to avoid the extreme scores (the lowest and the highest) and work in the middle of the scale. To avoid the error, the panelist should be trained and encouraged to use the scale in its entirety. Additionally, the scale itself should be large enough to accommodate significant differences between the samples. (10)

- Lack of motivation

The degree of motivation of panel members will affect how focused and consistent will they be in their judgements. Lack of motivation should be especially addressed when a sensory panel consists out of employees that perform sensory analysis in addition to other work responsibilities. To raise motivation in panel members, regular feedback on the performance should be given. When possible, the importance of panel activities should be emphasized. (4, 10)

2. PLANNING AHEAD

2.1 Objectives

The objectives of the analysis should be defined early on to ensure the success and relevance of the results. The correctly assessed objectives and expected results determine the rest of the experimental design and efficient use of resources. (10, 11, 12) The following question can help to define the objectives of the analysis:

- Are products different?
- How great/intense/significant is the difference between the products?
- What are the sensory properties of the product?
- What sensory properties are significant?
- How sensory properties change with time/processing/reformulation/packaging? (10, 11, 12)

2.2 Testing rooms and environment

Specific testing areas are required for sensory evaluation to ensure controlled conditions and reduce the external factors that may affect the judgement of the sensory panel members. The rooms designated specifically for sensory analysis should be located close to

the facilities where preparation of the samples for the analysis is going to take place. (4, 12, 13, 14)

The temperature and humidity levels of the testing area should be controlled and monitored at a constant rate. The recommended temperature is 22-24°C; relative humidity – 45-55%. Air circulation and ventilation systems should be in place. . (4, 12, 13, 14)

The testing area should be free of odors. A slight positive pressure can be maintained to prevent the inflow of air from outside. The construction materials should be free of specific odor and easy to clean if needed. The use of fabrics should be limited. The assessors are not allowed to use perfume/cologne or perfumed soap the day of the assessment. . (4, 12, 13, 14)

Testing environment should be free of noise and other distractions. The color of the walls and furniture should be as neutral as possible (white, beige, and light grey colors are recommended). The lighting should be uniform; the intensity of light source should be controlled and dimmed if necessary. Colored lights can be used to mask the color differences of the samples if required by the aims of the analysis. (4, 12, 13, 14)

To limit communication and distraction, independent judgement of the panelists can be promoted by building testing booths. The number of booths in the testing area largely depends on available free space. It is, however, recommended for a testing room to have enough space to fit 10-12 people with additional space available for unrestricted movement. A separate table with enough chairs should be available for group discussions. (4, 12, 13, 14)

2.3 Experimental design

2.3.1 The selection of sensory panel members

The pool of candidates for the sensory panel can be picked either within the company (Research & Development team members, office staff, or line workers) or from a number of volunteers outside the company. Having an in-house panel comprised out of workers has certain advantages since the members are then more familiar with the assessed products. However, if the company personnel cannot be made available for regular sensory assessments at least for 10 minutes at a time, the panel has to be assembled and trained from volunteers. (12, 13, 15, 16)

The potential candidates should be in good health (no allergies; no signs of color blindness, anosmia, or ageusia), possess availability, willingness, and motivation to participate in the assessment sessions on a regular basis and able to perform the tasks according to given instructions. Strong aversions to certain foods should be determined in pre-

screening sessions; potential panelists should be available to taste a wide range of products. Assessors may be required to make a consensus decisions based on the discussions; therefore, extremely dominant and very passive or indecisive personalities should be avoided. (12, 13, 15, 16)

2.3.2 Sensory panel size

A number of assessor involved in the sensory panel should be large enough to produce statistically significant results. In the sensory panel that is too small, the results are too dependent on the individual judgement of the assessor. However, even a small panel of highly trained assessors will most likely provide considerably significant results. (10, 12, 16) In some cases, the number of panel members depends on the nature of sensory assessment method (see Chapter 3. Sensory methodology in bread assessment). Due to workforce turnover (illness, change of employer), the size of the panel should be maintained constant and new members trained to fill the gap.

2.3.3 Number of samples

The number of samples presented to the panelists in a single session is limited by several factors. The analysis that involves the assessment of visual attributes allows considerably more samples than the analysis of odor and/or flavor due to odor and taste receptors being easily fatigued. Furthermore, if the number of attributes assessed in the one sitting is extensive, fewer samples should be given. Experienced panelists are able to produce reliable judgements faster with fewer sniffs, sips, or tastes of the product, making it possible to go through more samples in one session. (12)

In some cases, the number of samples presented to the panelists is strictly defined by the nature of sensory assessment method (see Chapter 3.1 Discrimination tests).

2.3.4 Sample preparation and presentation

Sample preparation should be done by following good laboratory and/or good hygiene practice. The portion sizes should be enough for sensory assessment. Too much of the sample will encourage assessors to take larger bites or sips causing sensory fatigue early on. (10)

In some cases, the sample presentation is dictated by the nature of sensory assessment method (see Chapter 3.1 Discrimination tests). Otherwise, there's a number of different sample presentation techniques used in sensory analysis. Most frequently used are sequential

monadic presentation and simultaneous presentation. In sequential monadic presentation, the samples are presented to panelists one by one. Samples are assessed separately in a timely manner. This order of presentation is thought to be the most appropriate if samples, for example, are temperature sensitive. In simultaneous presentation, all samples are given to the panelists at once. This technique of sample presentation is a common practice in discrimination tests (see Chapter 3.1 Discrimination tests) and ranking of the products based on specific attribute. (10)

2.3.5 Blind tasting and randomization

The assessment of samples should proceed in blind tasting conditions. In blind tasting, no background information is provided to the panelists about the samples and their source. Unnecessary information might affect the objectiveness of panel judgement and result in unreliable data (see Chapter 1.3 Factors affecting sensory perception). (17)

When multiple samples are presented to the panel, it is important to use randomization within the order of sample presentation. This way, the place of any specific sample in a line-up will always be different and reduce order effects (see Chapter 1.3 Factors affecting sensory perception). Additionally, the order in which the samples are received can be different for each assessor to maximize the positive effects of this approach. (10)

2.3.6 Number of parallels

The parallels in sensory assessment are defined by repeated judgements on a sample. The parallels are used to increase the reliability and statistical significance of the results. The parallels for the samples can be included in the same assessment session or done separately. The number of parallels largely depends on the sensory method used to achieve the objectives. In general, the methods used to confirm the existence of a difference between the samples favor the use of a larger panel with fewer parallels. The methods where the properties of the samples need to be described and scored require multiple independent judgements made by a trained panel. Two to three parallels are considered to be optimal. (10, 12)

2.3.7 Palate cleansing

To avoid the overstimulation of senses and carry-over effects, the palate should be cleansed between the samples. Still mineral water is widely used as a palate cleanser in sensory assessment; the oral cavity should be thoroughly rinsed to remove most of the

residual taste of a sample before moving on to the next one. In some specific instances mineral water won't be enough to provide sufficient palate cleansing. These instances include oily, spicy, and highly astringent foods. For oily products, slices of apple and pear can be recommended as an appropriate palate cleanser; for spicy foods – milk or yogurt; for astringent foods – melon. (10)

3. SENSORY METHODOLOGY IN BREAD ASSESSMENT

In general, methods for sensory analysis can be divided into 3 distinct categories based on the purpose of the tests and the questions to be solved:

1. Discrimination tests – Is there a distinct difference between samples?
2. Descriptive tests – How are the samples different?
3. Consumer tests – Which sample is the best (hedonic ratings)?

In this chapter, only discrimination and descriptive tests are introduced.

3.1 Discrimination tests

The purpose of discrimination testing is to determine if a difference exists between the samples by comparing them to one another. During the assessment of similarity or dissimilarity of the samples, the testing can be overall or attribute-focused depending on the objective. Discrimination testing methods, however, cannot be used if the difference between the samples is too obvious. (10, 12)

3.1.1 Triangle test

The triangle test is a method of discrimination testing designed to determine the existence of a difference between two products (A and B). In the course of the triangle test, the panelists are presented with three coded samples. One of the products is represented by one coded sample; the other product – by the rest of the coded samples in the line-up. The product can be mixed in a variety of line-ups: ABB, ABA, BAA, AAB, BBA, BAB. An example for bread samples in a triangle test is provided in Figure 6. It is recommended for each panelist to receive their own set with different coding and order of the samples. The panelists are then asked to either observe, sniff, and/or taste the samples in order and give a feedback on the existence and nature of the differences between the samples. On average, 20 to 40 subjects can be used for triangle testing to provide a statistically significant result.

However, if the panel is highly trained and/or differences might be relatively easy to identify, 12 assessors can be used. (4, 10, 12, 18, 19) Additional information on the panel size for triangle tests can be found in ISO 4120:2004 Sensory analysis – Methodology – Triangle test.

3.1.2 Duo-trio test

The duo-trio test is a method of discrimination testing designed to determine the existence a difference between two products (A and B) where one of the products is provided as a control sample. The panelists receive three coded samples. One of them (first in a line-up) is a clearly marked control, the rest of the samples is a pair of coded products A and B. The products can be mixed in a variety of line-ups: Control A AB, Control A BA, Control B AB, Control B BA. An example for bread samples in a triangle test is provided in Figure 7. The panelists are then asked to determine which sample of the two is the closest to the control and give a feedback on a nature of a difference in the leftover sample. Minimum of 16 assessors is required for duo-trio testing; statistical significance of the results is, however, much more improved with 32-40 or larger number of assessors. (4, 10, 12, 20) Additional information on the panel size for duo-trio tests can be found in ISO 10399:2010 Sensory analysis – Methodology – Duo-trio test.

3.1.3 “2 out of 5” test

The “2 out of 5” test is a method of discrimination testing designed to determine the existence a difference between two products (A and B) where the number of samples in a line-up is increased to five. One of the products is represented by two coded sample; the other product – by the rest of the coded samples in the line-up. The products can be mixed in a variety of line-ups: AAABB, ABABA, BBAA, BABAB, AABAB, BAABA, BBABA, ABBAB, ABAAB, ABBAA, BABBA, BAABB, BAAAB, BABAA, ABBBA, ABABB, AABBA, BBAAA, BBAAB, AABBB. An example for bread samples in a “2 out of 5” test is provided in Figure 8. The panelists are then asked to inspect the samples, group them based on the similarity, and provide a feedback on the nature of a difference between two formed groups. On average, 10-20 assessors can be used for “2 out of 5” test. If the panelists are highly trained and/or the difference between the samples is relatively easy to identify, 5-6 assessors are sufficient. (4, 12)

3.1.4 “A – not A” test

“A – not A” test is the easiest to conduct when trying to determine a sensory difference between the samples. In comparison to the rest of the discrimination tests mentioned above, more than two products can be involved in the process. The number of samples in a line-up for “A – not A” testing is also not strictly limited. The first sample in the line-up is always a clearly marked control (A). The panelists are then asked to inspect the rest of the coded samples in a series and determine whether they are similar to the control or not (not A). Additional feedback on the differences if any given samples is marked “not A” can also be provided. It is recommended for each panelist to receive their own set with different coding and order of the samples. An example for bread samples in a “A – not A” test is provided in Figure 9. 10 to 50 assessors can be used for this method with higher number of assessors providing more statistically significant results. (4, 18)

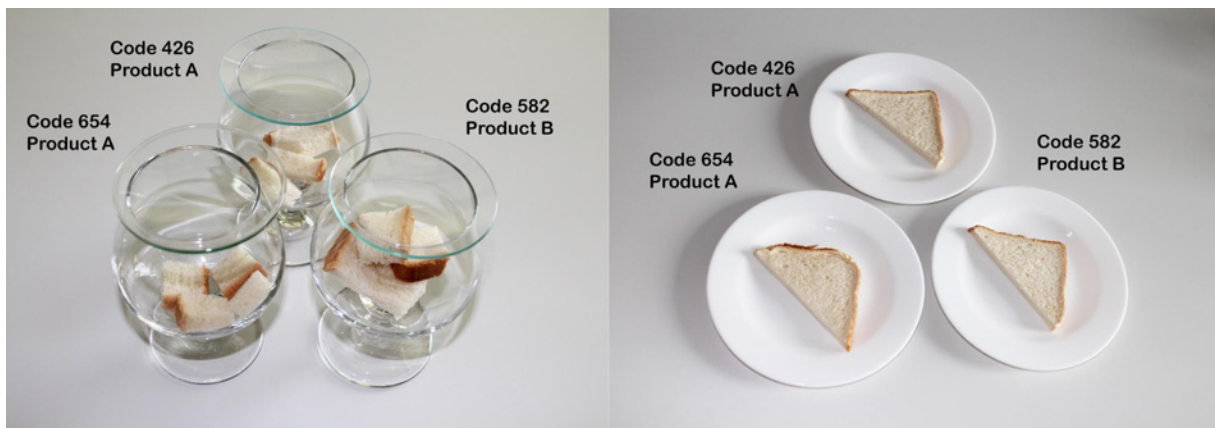


Figure 6. An example for bread samples in a triangle test. The products are mixed in a line-up AAB.



Figure 7. An example for bread samples in a duo-trio test. The products are mixed in a line-up Control B AB.

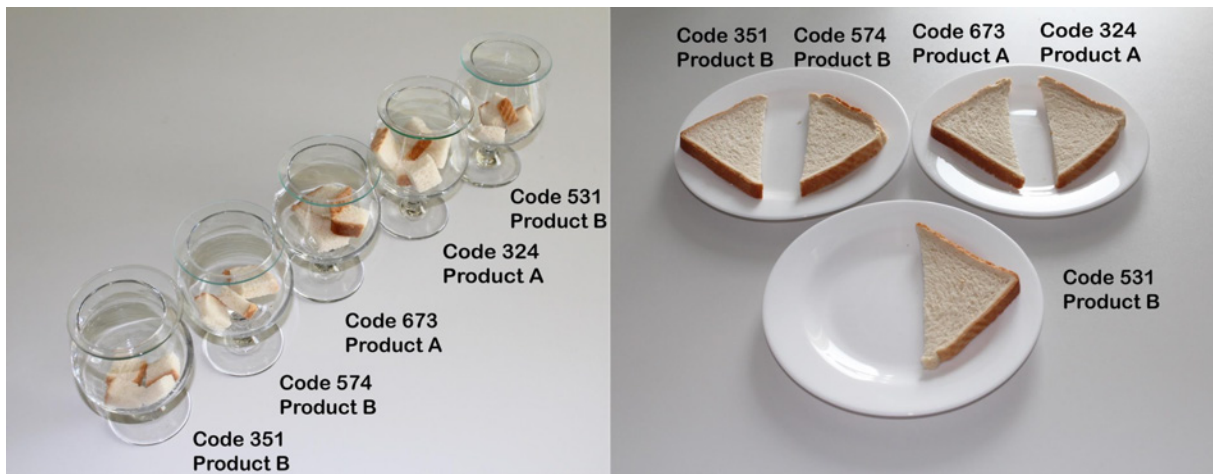


Figure 8. An example for bread samples in a "2 out of 5" test. The products are mixed in a line-up BBAAB.

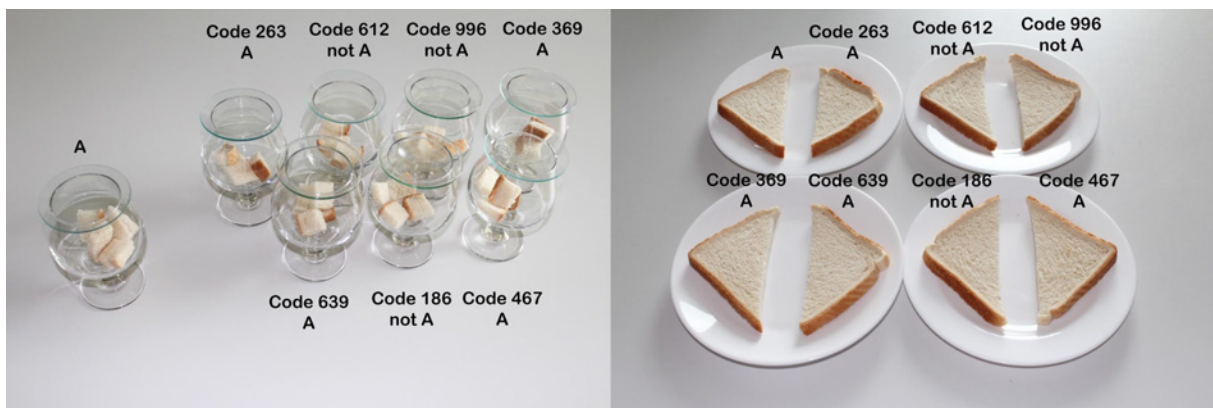


Figure 9. An example for bread samples in an "A - not A" test

3.2 Descriptive tests

Descriptive tests, as the name suggests, are used to describe the products using the sensory qualities perceived by the panel in appearance, odor, texture, and flavor. The intensity of perceived qualities is scored/graded, thus putting a numerical value on any existing differences. (10, 12, 21) On average, a panel of minimum 10 trained assessors can be recommended for descriptive analysis (22).

3.2.1 Terminology, reference materials, and definition sheets

The sensory assessment largely involves characterization and differentiation of different products based on their sensory properties. Objective description of sensory

properties required the development of appropriate terminology. Terminology in terms of sensory panel performance provides a uniform understanding of attributes that determines the accuracy and reliability of panel performance. (23, 24)

The set of words used to describe a product has to possess key aspects to aid sensory assessment. First and foremost, the use of precisely defined primary simple terms is encouraged. The use of simple terms instead of combination of several terms reduces confusion during the analysis and complication in data processing. Secondly, the terms used to communicate the sensory properties by the assessors have to be uncorrelated with each other. If the terms overlap in their meaning, a confusion within the panel might arise causing unnecessary errors. The terms should describe fundamental principles behind the sensory properties (physical, rheological, or chemical). (23, 24)

The process of terminology development for any particular product category involves multiple discussion sessions where broad selection of samples is given to the panel for individual assessment. Each assessor produces a list of attributes (=terms) that cover appearance, odor, texture, and flavor that can be used to define the product category. The suggestions of the panel members are combined and reviewed until consensus agreement and uniform understanding are achieved. (23, 24)

The primal aid in the discussion sessions is the use of reference materials. Reference material can be any chemical, ingredient, spice, or a separate product to help define the terms used in the process of sensory assessment (24). For example, sucrose solution is widely used as a reference material for the “sweet” attribute.

Based on the generated attributes and reference materials used to define them, the definition sheet is formed. The definition sheet includes a complete list of attributes to be assessed in the course of descriptive analysis, their detailed descriptions, appropriate reference materials, and the use of scale (see Chapter 3.2.3 Scaling).

3.2.2 Panel leader

For the purpose of facilitating and directing the process of descriptive sensory analysis, the sensory panel has to have a panel leader. The main responsibility of the panel leader is to ensure that the analysis is carried out correctly and in accordance with objectives. The panel leader should be able to advise on the correct procedure of descriptive analysis, organize the procedure, and report the results. (10, 12)

The role of a panel leader requires skill and extensive experience in the field of sensory analysis. The potential candidate has to know how to possess and use non-

judgemental, diplomatic approach, active listening, ability to handle diverse personalities and work challenges, ability to motivate, ability to recognize and remove bias. (10, 12)

3.2.3 Scaling

To grade the intensity of any perceived attribute either in terms of numbers or words, scaling is used. The effectiveness of scaling, however, largely depends on how familiar/trained panel members are with the scaling method used for the purpose of the analysis. Additionally, the panelist should be aware of how much the intensity of any particular attribute varies within the scope of a selected product. If a numerical scale is used, 10- to 15-point scales are considered to be wide enough to account for both drastic and relatively small changes in intensities. (4) If the words are used, the following indicators can be used: “no perceived sensation”, “mild sensation”, “moderate sensation”, “intense sensation”, “very intense sensation”. The reference materials used in terminology generation process (see Chapter 3.2.1 Terminology, reference materials, and definition sheets) can be additionally used as anchor points on the scales to aid the panelist and secure the uniformity of the results. The appropriate reference material for an attribute is assigned a value on a scale based on the panel consensus decision. The samples are then assigned the intensity value in relation to the reference material. (25)

3.2.4 Types of descriptive tests

Multiple different approaches to descriptive sensory analysis have been developed over the years. The most common approaches to descriptive analysis with a wide range of applications are flavor profiling method and quantitative descriptive analysis method.

The flavor profiling method is considered to be the basis of descriptive analysis, as it was developed first. During the analysis, the characteristics of the product, their intensities in the order of appearance are graded by a highly trained panel of 4-8 judges. The scales used for the flavor profiling range from 5 to 15 points depending on the nature of the products. Prior to the assessment sessions, the appropriate terminology and reference materials for attribute description are developed with the help of a panel leader. A wide scope of samples representing the product range or category is given in several separate sessions to familiarize the panel with naturally occurring variations in sensory attributes. Reference materials can also be used as intensity anchor points on the scale. During the official assessment, the panel

members first evaluate the samples individually; then, the consensus is achieved during the discussion session. (4, 26, 27)

Quantitative descriptive analysis[®] (QDA[®]) is a development of the flavor profiling method and the main descriptive analysis method to date. The method was designed with a purpose to improve the reliability of data for statistical analysis. As with the flavor profiling method, prior to assessment, the terminology is developed by using reference materials; the panelists are familiarized with the products. 15 cm line scale is used for scoring. A panel of 10 to 12 assessors is recommended. During, the assessment, only individual evaluation of the products is encouraged. The relative differences between the samples are scored. (4, 28, 29)

4. ANALYSIS AND INTERPRETATION OF RESULTS

In discrimination testing, the number of correct responses and the number of total responses should be counted. Furthermore, it should be emphasized to the participants that even if they do not feel the difference between the samples, they still have to make a random selection. “No difference” is not a valid response in this case. Interpretation of the results takes into the account the possibility of randomly given correct answer and, therefore, the response sheets without any proper selection should be left out from the analysis of data. To evaluate if there is a significant difference between the samples at a certain significance level (α -value), the corresponding numbers of correct responses for triangle and duo-trio tests are brought out in Table 2. If the number of correct responses is equal or larger than a specified value, it could be concluded that there’s a statistically relevant difference between the samples. (4)

As a rule, α -values can be selected based on the following:

- 0.10 – 0.05 indicates moderate evidence that the difference is apparent;
- 0.05 – 0.01 indicates strong evidence that the difference is apparent. (4)

As an example, if the total number of responses in triangle testing is 14, and the number of correct responses is 10, with α -value of 5% (0.05) we can conclude that there is a difference between the samples. However, if the same results are obtained in duo-trio testing, the conclusion is the opposite.

Table 2. Critical number of correct responses in triangle test (before the dash) and duo-trio test (after the dash); n – total number of responses, α -significance level (4)

n	α						
	0.40	0.30	0.20	0.10	0.05	0.01	0.001
8	4/5	4/6	5/6	5/7	6/7	7/8	8/-
9	4/6	5/6	5/7	6/7	6/8	7/9	8/-
10	5/6	5/7	6/7	6/8	7/9	8/10	9/10
11	5/7	5/7	6/8	7/9	7/9	8/10	10/11
12	5/7	6/8	6/8	7/9	8/10	9/11	10/12
13	6/8	6/8	7/9	8/10	8/10	9/12	11/13
14	6/8	7/9	7/10	8/10	9/11	10/12	11/13
15	6/9	7/10	8/10	8/11	9/12	10/13	12/14
16	7/10	7/10	8/11	9/12	9/12	11/14	12/15

For descriptive analysis, the first approach is to look for the panelists who scored the samples in considerably different manner than the rest of the panel. Additionally, typos or other mistakes can occur as well, which can affect the interpretation of the results. Next, the mean values for each attribute and product are calculated (Calculation 1). Mean values are very sensitive to extreme values in data (outliers) and, therefore, it is suggested to check the data for outliers first. (4)

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{n} = \frac{(x_1+x_2+x_3+\dots+x_n)}{n} \text{ (Calculation 1)}$$

In addition to mean values, standard deviations are also calculated (Calculation 2).

$$s = \sqrt{\sum_{i=1}^n (x_i^2 - \bar{x})^2 / (n - 1)} \text{ (Calculation 2)}$$

where x_i is a single observation, and \bar{x} the mean value.

Large values in standard deviations refer to the lack of consensus between panel members or differences in scaling. If the standard deviations are larger than the differences between the mean values, it may indicate that the means are the same and there is no significant difference between the samples in terms of attribute in question. To evaluate if the means are statistically different t-tests and analysis of variance (ANOVA) can be used. (4)

5. APPLICATION OF SENSORY ANALYSIS – PRODUCT DEVELOPMENT AND QUALITY CONTROL

Product development is actively used by the manufacturers to achieve a competitive edge on the market where consumer awareness has reached its peak. Once the competitive edge is achieved through new and innovative products on the market, it has to be maintained by using quality control measures to ensure stable quality of the products. Both product development and quality control should benefit the company and the consumer. The consumer gets consistent quality and overall satisfaction with the purchases; the company achieves increased sales, increased profits, and customer loyalty to the brand. Both in product development and quality control systems, sensory analysis plays a primary role due to the fact that it provides a realistic view of how consumers perceive or will potentially perceive a product. (13, 30)

Product development starts with consumer expectations. Market research and statistics on sales can provide a sufficient insight into what properties in what products the consumers want and expect to see – the demand guides the product development department to introduce new products with certain properties. However, once the product is formulated and/or appropriate technologies developed, suitability of the results has to be controlled and documented to aid further approval or additional improvements. In product development, technological advances go hand-in-hand with sensory analysis. Sensory analysis can characterize and estimate the magnitude of changes in a product due to addition of certain ingredients, interactions of multiple ingredients and their ratios, and different technological approaches. To evaluate if the changes influence the sensory properties of products significantly, difference tests should be applied. If it is revealed that the difference is remarkable, descriptive analysis could be applied to better understand the nature of differences. Combined with a knowledge from the experts, the production can be further adjusted to meet the end criteria. (12, 13, 31)

Quality control systems include routine tastings of the products to ensure the stability of quality and its conformity to technological specifications and standards. In-depth knowledge of product lines and awareness of normal batch-to-batch variations are required within the sensory panel members to recognize the changes that are not acceptable. Routine tastings could be built up as descriptive tests where the anchor points are based on the knowledge on the specified value for certain product. Sensory analysis is particularly useful in shelf-life evaluation and off-flavor (=taint) development monitoring. In shelf-life studies, the

limit of shelf-life is considered to be a point where noticeable/detectable changes start occurring in the sensory properties of the product under normal storing conditions. Again, discrimination tests could be used as the first measure to evaluate if the changes are detectable. Abnormal shifts in sensory attribute intensities or a development of atypical volatile compounds in the food matrix can lead to the development of off-flavors or taints. Off-flavors are a primary reason behind consumer complaints and product recalls. Sensory analysis can be used as a precaution step to catch off-flavor prior to the defective product entering the market and aid in identification of the nature of off-flavor to prevent it from happening again in the future. (12, 13)

6. PANEL TRAINING AND MAINTENANCE

6.1 Training program

Once the candidates for the sensory panel are selected (see Chapter 2.3.1 The selection of sensory panel members), the training program should be established and applied. Despite the fact that some of the panel members might have an excellent knowledge about the products produced within the company, their properties, and quality requirements, the critical technical skills in sensory assessment should still be established. The training should be conducted by a professional in the field.

The formal sensory training is generally divided into two parts: basic training, and product-specific training. Basic training should start with a series of lectures or seminars where sensory perception and its nuances are discussed; sensory assessment and its methods, the importance of sensory analysis in food production, and applications are introduced. Practical training should begin with several detection and recognitions tests for both odor and taste. Primary tastes and different volatile compounds at various intensities are introduced in the course of the basic training. The detailed procedures are described in ISO 3972:2011 – Sensory analysis – Methodology – Method of investigating sensitivity of taste and ISO 5496:2006 – Sensory analysis – Methodology – Initiation and training of assessors in the detection and recognition of odors. As a result, taste detection threshold are established for the panel members; certain sensitivity in the detection of volatile compounds can be estimated; the panel members are introduced to the nature of tastant and odor-active volatile compounds in practice; the concept of intensity of sensory perception is introduced to the panel members. Additional sessions are then recommended to introduce the subject of off-flavors/taints to the panel members. Several examples from different product categories should be discussed and

odor compounds presented for familiarization. Once the training becomes product-specific, a detailed approach to off-flavors can be taken. (12, 13, 32, 33)

In product-specific training, the panel members learn to evaluate the variations in sensory properties. The process of product-specific training begins with introducing samples within the chosen product category of various intensities (low, medium, and high). If needed, the products can be altered to provide the drastic differences. Altering the products is also useful when teaching the off-flavors. When training the panel for a specific product category, reference materials play an important role. Aside from terminology development (see Chapter 3.2.1 Terminology, reference materials, and definition sheets), the use of reference materials in training shortens the training time by aiding in sensation description and overall learning process. However, the reference materials should be introduced to the panelists after the several opportunities are given to describe the products and sensory attributes independently with no additional aid. Reference materials used should be always documented for future trainings. Separate training sessions should be done for discrimination and descriptive tests. Evaluation procedure and scoring are covered. (4, 12, 13)

The number of sessions necessary for the training partially depends on the complexity of the food product category. The panel should continue simulated evaluations until a certain level of confidence and reliability of the results has been reached. (4, 12, 13)

6.2 Panel maintenance

Once the panel is established, trained, and performing, the panel maintenance should be applied to deal with physiological and psychological factors inherent in sensory work. The psychological factors are the main issue in panel maintenance when routine analysis is involved. Frequent participation in routine assessments (mostly related to quality control) might lead to loss of motivation among panel members. If the products in day-to-day assessment are too similar, the feeling of boredom might arise. Because of that, the results might suffer from the lack of alertness and focus. To maintain panel interest, several additional steps can be taken from time to time in the framework of panel maintenance. First of all, regular feedback on the performance should be given to the panel members; emphasis on the strong points and recommendations for further improvements should be given. Tangible feeling of progress can keep panel members on their toes and motivated to keep going. To combat both lack of motivation and adaptation to the samples, it is good to organize review sessions or assessment sessions with artificially spiked or inherently drastically different samples. (4, 13)

7. MATERIALS FOR DESCRIPTIVE SENSORY ANALYSIS OF BREAD

7.1 Definition sheets

BREAD ASSESSMENT DEFINITION SHEET SCALE 0...15

Modality	Attribute	Attribute description ¹	Reference material ¹	Reference value on the scale
Appearance	Crust color	The degree of color in the crust (beige to dark brown)	Visual scale ²	---
	Crumb color	The degree of color in the crumb (beige to dark brown)	Visual scale	---
	Surface texture	Surface texture of the crust (smooth to rough). If additives (nuts, seeds, fruits, etc) are present on the surface of the crust, they are omitted from surface texture assessment.	Visual scale	---
	Pore size	Pore size in the crumb (small to large)	Visual scale	---
Odor	Overall odor intensity	Overall strength of the perceived odor	--- ³	---
	Sour	Strength of all sour notes in odor	Plain yoghurt	12
	Sweet	Strength of all sweet notes in odor	Milk	6
	Dairy	Strength of notes characteristic to milk-based products	Milk	6
	Yeasty	Strength of notes characteristic to active yeast	Dry yeast	12
	Grainy	Strength of notes characteristic to grains	Whole-wheat flour	12
	Nutty	Strength of notes characteristic to nuts	Hazelnuts	10
	Toasted	Strength of notes characteristic to toasted bread	Toasted bread	12
Buttery	Strength of notes characteristic to butter	Butter	8	

¹ The reference materials are primarily required as a training material. More involved descriptive analysis might require reference materials as anchor-points for scaling. However, in daily quality control reference materials are not necessary; instead, relative scaling where all products are rated against each other can be used.

² The colors on the provided visual scale might slightly vary depending on the resolution of a display and the properties of a printer.

³ The choice of a reference material for “overall odor intensity” attribute largely depends on the products characteristic to the portfolio of a manufacturer. For this attribute, it is recommended for each manufacturer to pick a product from their own product range and use it as a reference material.

Modality	Attribute	Attribute description	Reference material	Reference value on the scale
Flavor	Overall flavor intensity	Overall strength of the perceived flavor	---	--
	Sour	Strength of basic sour taste	0.025% lactic acid	7
	Sweet	Strength of basic sweet taste	1% sucrose	7
	Salty	Strength of basic salty taste	0.15% table salt	7
	Dairy	Strength of flavor characteristic to milk-based products	Milk	6
	Yeasty	Strength of flavor characteristic to active yeast	Dry yeast	12
	Grainy	Strength of flavor characteristic to grains	Whole-wheat flour	12
	Nutty	Strength of flavor characteristic to nuts	Hazelnuts	10
	Toasted	Strength of flavor characteristic to toasted bread	Toasted bread	12
	Buttery	Strength of flavor characteristic to butter	Butter	8
Texture	Softness	Force required to bite through the sample (from hard to soft)	Soft waffle	5
	Moisture	Amount of moisture perceived when the samples contacts with the oral cavity (from dry to moist)	Soft waffle	7
	Adhesiveness	The amount of sample that remains on the teeth after chewing 5 times (from “not adhesive” to “adhesive”)	Soft waffle	5
	Crumbliness	The number of particles released when tearing the sample in half (from “doesn’t crumble” to “crumbles”)	Soft waffle	2
	Springiness	Assess the speed of surface recovery 5 seconds after pressing with a finger (from “not springy” to “springy”)	Soft waffle	13

⁴ The choice of a reference material for “overall flavor intensity” attribute largely depends on the products characteristic to the portfolio of a manufacturer. For this attribute, it is recommended for each manufacturer to pick a product from their own product range and use it as a reference material.

**ADDITIVES ASSESSMENT DEFINITION SHEET (NUTS, SEEDS, FRUITS, ETC)
SCALE 0...15**

Modality	Attribute	Attribute description	Reference material	Reference value on the scale
Appearance	Amount	The amount of additive visible in the cross-section of the crumb (very few to a lot)	Visual scale	---
	Distribution	How evenly are additive distributed throughout the cross-section of the crumb (uneven to even)	Visual scale	---
Odor	Odor intensity	Strength of all notes characteristic to the additive	--- ⁵	---
Flavor	Flavor intensity	Strength of flavour characteristic of the additive	--- ⁶	---

⁵ Reference material for overall odor intensity of the additives depends largely on the nature of the additives. For example, if dried fruits are used as an additive to the bread, the same dried fruits should be used by the manufacturer as a reference material.

⁶ Reference material for overall flavor intensity of the additives depends largely on the nature of the additives. For example, if dried fruits are used as an additive to the bread, the same dried fruits should be used by the manufacturer as a reference material.

OPTIONAL ATTRIBUTES (USE WHEN RELEVANT)
SCALE 0...15

Modality	Attribute	Attribute description	Reference material	Reference value on the scale
Appearance	Crust color consistency	How uniform is the color in the crust throughout the whole loaf surface (from uneven to even)	Visual scale	---
	Floury surface	How much of crust surface is covered in flour (from “not floury” to “floury”)	Visual scale	---
	Surface shine	The level of surface shine (from matte to shiny)	Visual scale	---
Mouthfeel	Fatty	Strength of flavour characteristic of the additive (from “not fatty” to “fatty”)	Coffee cream	13

7.2 Sample preparation

For the purpose of crust assessment, the bread should be presented to the panel members as a whole loaf (Figure 10). This way, the attributes are more visible and distinguishable. To assess the crumb, the loaf should be cut in half or into slices (Figure 11). This way, the cross-section is the most visible.

For the purpose of odor assessment, the slices of bread should be cut into 1 cm x 1 cm pieces. If general assessment is required, the crust should be included when cutting into pieces. Otherwise, the crust should be cut off beforehand. When the bread is evenly cut, 4 pieces should be placed into a sniffing glass and covered (Figure 12). Each panel member should receive their own sniffing glass.

For the purpose of taste and texture assessment, a whole slice of bread should be served to each panelist on a plate of neutral color (preferably white) (Figure 12).

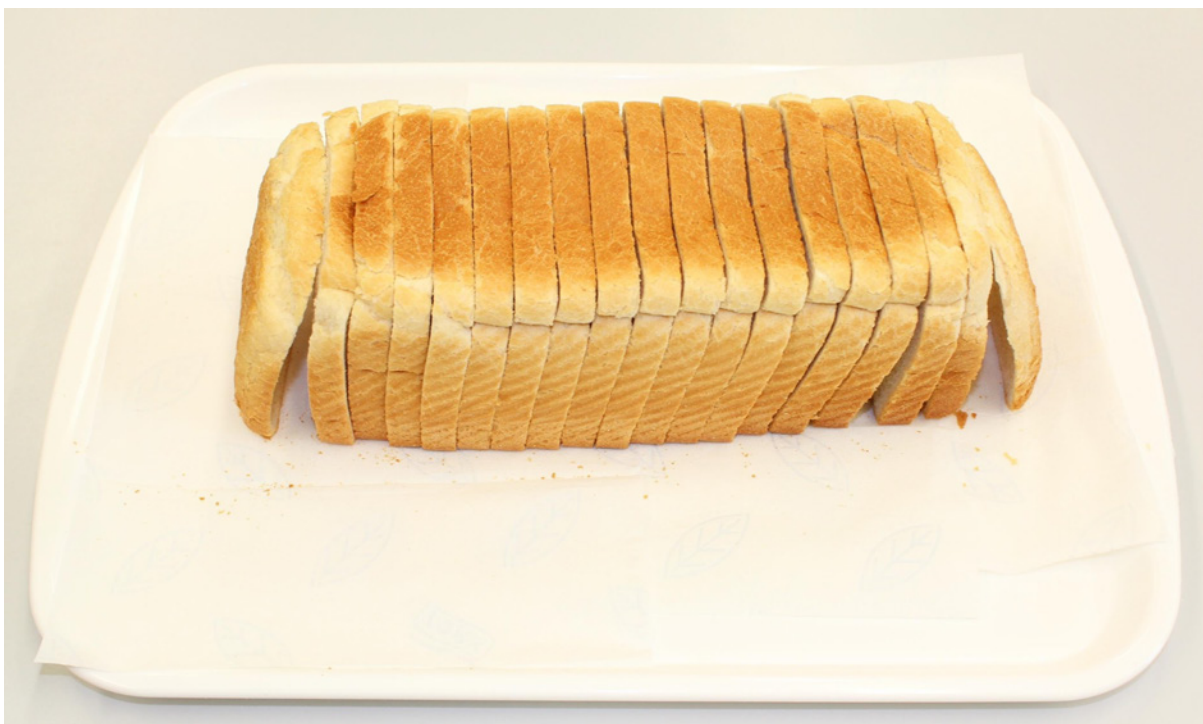


Figure 10. Loaf of bread presentation for appearance assessment



Figure 11. Bread cross-section presentation for appearance assessment



Figure 12. Bread presentation for odor (in a sniffing glass), taste, and texture (on a plate) assessment

7.3 Reference material preparation

7.3.1 Appearance

For the appearance assessment, the visual scales are used.

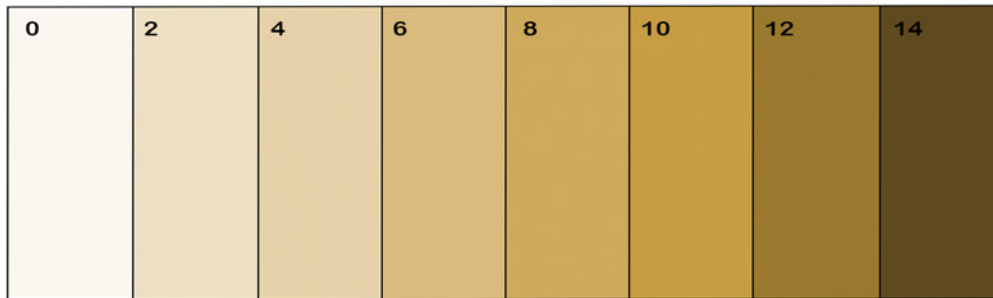


Figure 13. Visual scale for crust/crumb color assessment



Figure 14. Visual scale for surface texture assessment

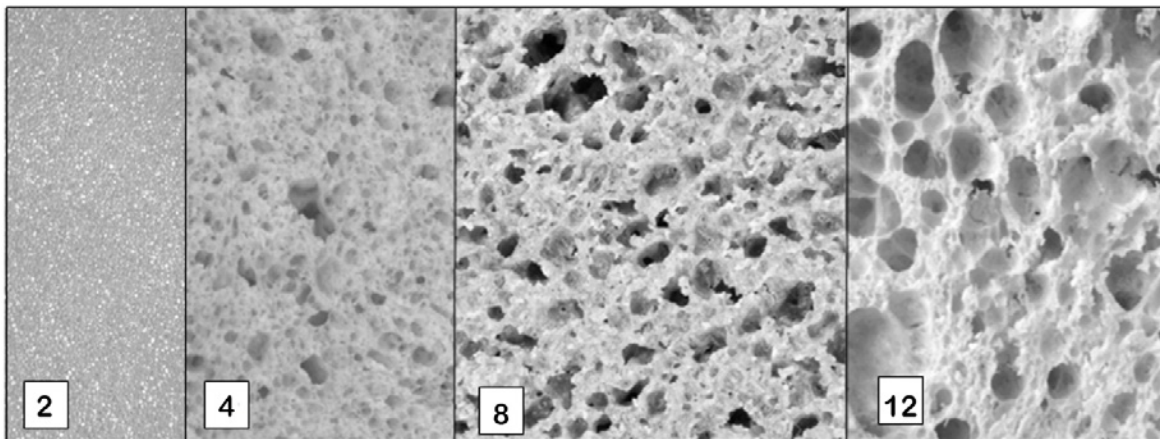


Figure 15. Visual scale for pore size assessment

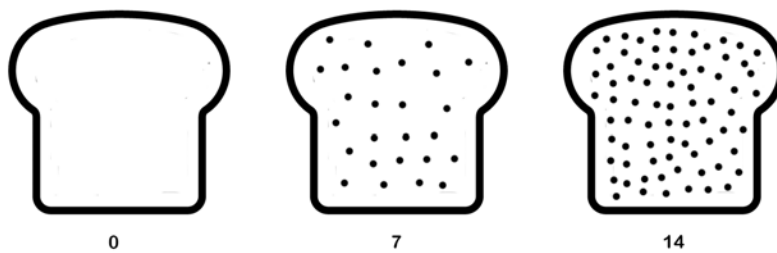


Figure 16. Visual scale for the amount of additives assessment (optional attribute)

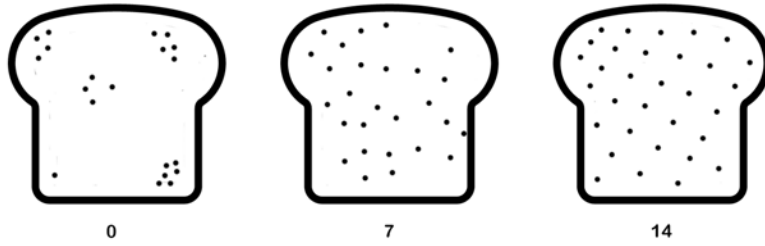


Figure 17. Visual scale for the distribution of additives assessment (optional attribute)



Figure 18. Visual scale for color consistency assessment (optional attribute)

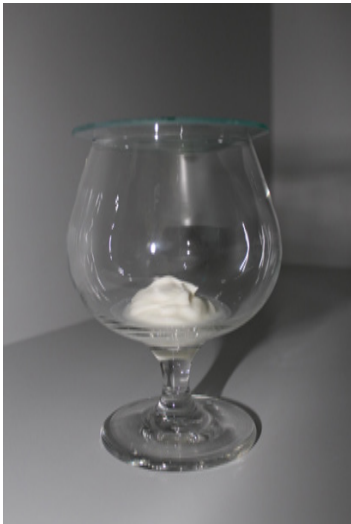





Figure 19. Visual scale for floury surface assessment (optional attribute)






Figure 20. Visual scale for surface shine assessment (optional attribute)

7.3.2 Odor


Reference material	Preparation procedure	Presentation
Plain yoghurt	Dose 1 teaspoon of plain yogurt into a sniffing glass.	
Milk	Dose 20 mL of milk into a sniffing glass.	



<p>Dry yeast</p>	<p>Mix 0.5 g of dry yeast with 15 mL of warm water into a sniffing glass.</p>	
<p>Whole-wheat flour</p>	<p>Mix 1 teaspoon of whole-wheat flour and 40 mL of water into a sniffing glass.</p>	

<p>Hazelnuts</p>	<p>Crush 2 hazelnuts into a sniffing glass.</p>	
<p>Toasted bread</p>	<p>Toast a slice of bread on a frying pan until crispy. Cut the slice of toasted bread into 1 cm x 1cm pieces. Put 4 pieces into a sniffing glass.</p>	

Butter	Cut out a 1 cm x 1 cm piece of butter and put it into a sniffing glass.	
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7.3.3 Taste

Reference material	Preparation procedure	Presentation
0.025% lactic acid	Dissolve 0.25 g of lactic acid in 1 L of filtered water. Dose 20 mL of the solution into shot glasses.	

1% sucrose	Dissolve 10 g of sugar in 1 L of filtered water. Dose 20 mL of the solution into shot glasses.	
0.15% table salt	Dissolve 1.5 g of table salt in 1 L of filtered water. Dose 20 mL of the solution into shot glasses.	
Milk	For preparation procedure see Chapter 7.3.2 Odor	---
Dry yeast	For preparation procedure see Chapter 7.3.2 Odor	---
Whole-wheat flour	For preparation procedure see Chapter 7.3.2 Odor	---
Hazelnuts	For preparation procedure see Chapter 7.3.2 Odor	---

Toasted bread	For preparation procedure see Chapter 7.3.2 Odor	---
Butter	For preparation procedure see Chapter 7.3.2 Odor	---

7.3.4 Texture/Mouthfeel

Reference material	Preparation procedure	Presentation
Soft waffle	Cut a soft waffle into 4 cm x 4 cm pieces. Serve on a plate of neutral color (preferably white).	
Coffee cream	Dose 20 mL of coffee cream into shot glasses.	

7.4 Assessment guidelines

7.4.1 Appearance assessment

The appearance of bread is assessed first. For that, a whole loaf is presented to the panelists. Crust coloring, surface texture, and some of the optional attributes if necessary (crust color consistency, floury surface, surface shine) are assessed first. For the most part,

only top portion of the loaf is taken into account. However, if by panel decision it becomes necessary to assess crust color consistency, the top of the loaf as well as the sides should be viewed.

If the loaf is not pre-sliced, it should be then cut in half to assess crumb coloring, and amount and distribution of additives if thought necessary.

7.4.2 Odor assessment

Immediately after appearance comes odor assessment. Each panel member should be provided with their own set of samples. If the reference materials are used for odor assessment, a set of references per 2-3 panel members is sufficient. For each attribute to be assessed, a reference material should be sniffed first if used. A deep inhale of 3 seconds is recommended for each sniffing turn. A pause of 10 seconds should be taken between sniffs to partially restore the olfactory receptors.

7.4.3 Flavor assessment

After odor, flavor is assessed. Each panel member should be provided with their own set of samples and basic taste solutions as references (lactic acid for “sour”, sugar for “sweet”, salt for “salty”). Water is used as a palate cleanser. As in odor assessment, for each attribute, reference material is assessed first if used. It should be noted that for “dairy”, “yeasty”, “grainy”, “nutty”, “toasted”, and “buttery” reference materials in sniffing glasses are used. This means that when assessing these parameters, reference materials are sniffed. When tasting the samples, the retronasal olfactory perception is graded and compared to the references. Between tastings, palate is thoroughly cleansed with water by swishing the water in the mouth for ca 5 seconds.

7.4.4 Texture/mouthfeel assessment

Texture and/or mouthfeel are assessed last. Texture parameters that can be assessed with hands (crumbliness, springiness) are viewed first. If references are used, for each attribute they are assessed before the samples. As with flavor assessment, water should be provided as oral cavity cleanser between the samples.

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