Lexicon, sensory wheel and kit as sensory communication tools: a review

N E Asih¹, K P Ramadhanty¹, J Ramandias¹, F Azkarama¹ and W B Sunarharum¹²*
¹Sensoflavo Sensory Collaborative Works, Malang, Indonesia
²Brawijaya Senso-Gastronomy Centre, Department of Agricultural Product Technology, Faculty of Agricultural Technology, Universitas Brawijaya, Malang, Indonesia
*Email: wbsunarharum@ub.ac.id

Abstract. A lexicon comprises a collection of standardized sensory vocabulary of product along with its unambiguous definitions and references. It is widely used as a communication tool among sensory panel and it provides sensory insights to product developers, marketing professionals, and suppliers, across countries or cultures to describe similar products. Specific sensory lexicon have been developed for beverages, dairy, fruits and vegetables, nuts and grains, soy and meat products, and animal feed. Based on its lexicon, a sensory wheel can be established hierarchically as an overview of the entire product’s sensory attributes. Furthermore, an intense training for panels is necessary to get a good sensory judgement. Sensory panel calibration can be performed such as by using sensory kit as a training tools. The aim of this paper is to review the latest developed lexicon, sensory wheel and sensory kit, as well as its application.

1. Introduction

A lexicon is a collection of standardized sensory vocabulary of product developed using sensory descriptive analysis methods, along with each attributes’ descriptions and references preparation instruction [1]. It is widely used as a relevant communication tool among sensory panel and scientists, product developers, marketing professionals, and suppliers, across countries or cultures to describe similar products. Specific sensory lexicon have been developed for beverages, dairy, fruits and vegetables, nuts and grains, soy and meat products, and animal feed. Based on its lexicon, a sensory wheel can be established hierarchically as an overview of the entire product’s sensory attributes. Moreover, lexicon play a major role to describe the sensory attributes of products consistently due to differences in perception, background knowledge, and culture among sensory panels [3]. Specific sensory lexicons have been developed and published before 2019 for various food and beverages [1], [4,5]. The developed lexicon can be carried out based on the corresponding references of each term, thus it can be interpreted in the same manner by both present and future panelists [6].

Sensory lexicons can be further established into a sensory wheel. It is generally visualized as a hierarchical wheel structure based on its lexicon that represent the entire product’s sensory attributes [7] (e.g. the coffee wheel) and sometimes divided by the main sensory attributes category [1] (e.g. white wine has a separate aroma and mouthfeel wheel). Basically, a sensory wheel starts at the center and works outwardly. It is constructed with the most general sensory attributes near the center and the attributes get more specific as the tiers work outward [8]. Similar attributes are placed in the same categories and subcategories whereas less similar are placed further away from one another [9].
Prior to sensory evaluation, specifically for most descriptive tests, an extensive and in-depth training for panels is necessary [10]. The training of descriptive panels also refers as calibration by using reference standards given in training to internalize their frame of reference for the scale and build up precisely those sorts of memory references that may collect a good sensory judgement in the end. The reference standards used mostly in the form of sensory kits such as aroma kit and flavor kit were used in several sensory studies [11,12] and it proven to be a reliable training tools in the sensory fields. The aim of this paper is to review the latest developed sensory lexicon, sensory wheel and sensory kit, as well as its application.

2. Method
The methodology of this paper was a systemic review which conducted in a systemic manner, according to a pre-specified protocol to minimize bias in order to synthesizing the retrieved information [13]. The selected literatures were mostly published after 2016 and were obtained from several leading journals such as Journal of Food Science, Food Research International, Food Science & Nutrition, Journal of Sensory Studies, Foods, and other journals as well as related publication sources. The keywords used were “sensory lexicon”; “sensory wheel”; “aroma kit”; “sensory kit”; “Le Nez du”; and “FlavorActiV”.

3. Results and discussion

3.1. Sensory lexicon and its application
Previously, Lawless and Civille [1] Drake and Civille [4], and Suwonsichon [5] reviewed the developed sensory lexicon which published before 2019 for numerous products including beverages, dairy, fruits and vegetables, nuts and grains, soy and meat/fish products, animal feed, and other miscellanea. This paper covers the latest 36 sensory lexicons published after 2017 and has not been mentioned by previous authors. It consists of several categories, including fruit and vegetable, grain and nut, beverage, milk, chocolate, spice, sauces and stock, snack and bakery, oil and smoked food. The latest sensory lexicons mentioned in Table 1 were developed by trained panels through descriptive analysis and some of them combined with new sensory method and opinion from consumers.

3.1.1. Fruit and vegetable. A lexicon for omija fruits in different form (raw, pureed, freeze-dried, and hot-air dried) was developed specifically to understand the roles of identified key aroma-active compounds on human sensory perception and their potential interactions with other compounds and the food matrix [14]. A lexicon to provide common terminology between breeders, producers, marketers, and researchers for different potato cultivars was established in fresh [15] and cooked form [16]. Several lexicons aimed to help plant breeders in selecting and improving quality traits that influence consumer acceptance were found for fresh peach [17], strawberry [18], kale and related leafy Brassicas [19]. A lexicon for mushroom was established to describe its flavor properties in fresh, dried and powder form [20].

3.1.2. Grain and nut. Lexicons for different varieties of almond [21] and quinoa [22] were established to describe its quality. A lexicon for sorghum was developed to characterize its flavor as grains and in finished products [23]. A lexicon for the characterization of cooked dried long pasta was developed as an effective foundation for its sensory evaluation among researchers, producers, retailers, and marketers [24].

3.1.3. Beverage. In fruit juices sector, lexicons for apple juice [25] and pomegranate-based smoothies mixed individually with fig; jujube; and quince [26] were developed. A lexicon for wooden barrel aged beer was developed to monitoring the aging process which relies mostly on changes in sensory parameters over time [27]. The creation of apple juice and barrel aged beer lexicon was involving Ultra-flash profile (UFP), an alternative to the Quantitative Descriptive Analysis (QDA®) by replacing formal training prior to QDA® and describing the product by free-word text instead of a score, thus it suitable
for product holistic characterization among expert tasters [28]. A lexicon for cold brew coffee was
developed to provide insight into different flavors imparted by different cold brew methods and insights
for consumer preferences of different cold brew flavors [29]. A lexicon for different kind of tea i.e.
Hunan fuzhuan brick tea [30], Mate tea [31], and Rooibos tea [32] also have been created for describing
the diversity of their sensory attributes.

3.1.4. Milk. A lexicon for almond milk powder [33] was developed based on previous studies [21,34],
[35] to describe attributes of almond milk in powder enriched with probiotics manufactured from
hydroSOSTainable almonds (i.e. generated under water stress condition) and compare it with the
commercial one. A lexicon for commercial tiger nut milks was developed [36] based on lexicon from
their previous study [37].

3.1.5. Chocolate. Commercial chocolate products (milk, white and dark chocolate) in Belgium were
examined and developed its lexicon [38] by using sensory attributes generated from trained chocolate
consumer. The use of the most important attributes and decisive factors in the choice of chocolate
products consumers is crucial for companies as well as scientists who using chocolate products.

3.1.6. Spice. Flavor lexicon for Sichuan pepper, a typical spice in China’s cuisines, was developed to
distinguish the aroma and flavor among commercial samples [39]. A lexicon for wide array of dried
spice and herb was developed to tackle the potential misunderstanding of the complete sensory profile
of spices [40].

3.1.7. Sauce and stock. Lexicon for some traditional sauce products was established, such as
Kanyebwa sauce (a typical bean sauce originated from Uganda) [41] and Deonjang (a fermented soybean paste or
sauce originated from Korea) [42]. A lexicon for commercially available chicken stock products was
developed to evaluate its consumer acceptability [43]. Red sufu, a subtype of fermented soybean curd
products which has red color, was examined to develop its lexicon [44]. A sensory lexicon for soy sauces
has been established specifically to describe its quality during storage [45].

3.1.8. Snack and bakery. Lexicons for some particular region snack and bakery were found specifically
for Nuroongji (a traditional rice-based snack originated from Korea) [46] and Waterford Blaa as an Irish
Protected Geographical Indication (PGI) product [47]. A lexicon for rye bread was developed to
understanding the flavor profile of rye bread consumed in the United States and Northern Europe [3].

3.1.9. Oil. The sensory terminology of marine oils was established in order to provide an accurate
representative description of oil quality and can be used as a valuable tool for quality control [48].

3.1.10. Smoked food. Several market products and samples smoked in-house were examined and
developed its lexicon which can be used to evaluate the smoke flavor on all types of food products [49].

3.2. Sensory wheel
Ten out of thirty six lexicons covered in this paper were further visualized into sensory wheel. They are
kale, apple juice, barrel aged beer, Hunan fuzhuan brick tea, honeybush tea, roboois tea, wine, chocolate,
spice, and marine oil. Their sensory lexicon along with its sensory wheel were developed as several
ways. First, as the first attempt at developing its lexicon such as for kale [19], Hunan fuzhuan brick tea
[30], roboois tea [32], chocolate [38], and marine oil [48]. Second, as an updated version of its previous
lexicons to create more generic one by using large sample set such as honeybush tea [50]. Third, as a
development of more specific and straightforward lexicon such as for single-cultivar product
characterization of apple juice [25] and barrel aged beer [27]. Forth, as an enhancement of its previous
lexicons such as Text-Based Wine Wheel which based on the terms extracted automatically from corpus
of wine expert [51] as well as McCormick Spice Wheel as an upgrade of the original Spice Wheel in
the mid-1990s [40] which categorized its attributes according to their similarities by professionals panels.

3.3. Sensory kit
Sensory kit is a set of non-food grade aromatic liquids made from single or a mixture of synthetic compounds or by aroma extraction and placed in glass vial for olfactory system training, known as aroma kit, or food-grade encapsulated compounds for both olfactory and gustatory system training, known as flavor kit. Generally, aroma kit is used by sniffing the vial whereas flavor kit used by dissolving the capsules into any liquid which can be both smell and drink. Some of the well-known sensory kit producers which available globally are The Jean Lenoir company (aroma kit), SCENTONE (aroma kit), and FlavorActiV (flavor kit).

3.3.1. Aroma kits and its application. In 1981, Jean Lenoir, an oenologist, invented Le Nez du Vin®, a unique book-object, combining writings in encyclopedia format and liquid scents placed in vials [52]. It helped both professionals and amateurs for describing different aromas in wines. Many more book-objects had been created for various purpose such as whiskey scents, coffee aromas, cigar testing and many more.

Le Nez du Vin aroma kit has been used in several studies such as by Tao et al. [53] for panelist training of Cabernet Sauvignon dry red wine aroma assessment and Fujioka et al. [11] which used Le Nez du Vin to be recorded by an electronic nose and it successfully described coffee aroma as how wine experts describe wine aroma.

A specific aroma kit for coffee was established by The Korea Coffee Promotion Foundation (KICCI) and company specializing in aromatherapy senton (SCENTONE) in early 2016, marketed as Coffee Flavor Map T100, a compact version of coffee aroma kit with 100 of the most representatives flavors contained in coffee [54]. It is used in Authorized SCA Trainer course by Specialty Coffee Association (SCA), as well as by coffee enthusiast around the world. Additionally, SCENTONE aroma kit is certified by SCAA (Specialty Coffee Association of America) and in accordance with Coffee Taster’s Flavor Wheel which established by World Coffee Research (WCR) and SCA.

Recently, the first aroma kit for Indonesian coffee, Sensoflavo Coffee Aroma Library (CAL), have been developed by Sensoflavo Sensory Collaborative Works [55]. It presents 18 general aroma references that might be found in coffees using more recognizable vocabulary for Indonesians. This coffee sensory education tool can be used not only for those who are working on evaluating coffee quality such as coffee grader, quality controller, baristas, processors and farmers, but also consumers who are interested to identify and study coffee aromas.

3.3.2. Flavor kit and its application. To date, the only company that produces flavor kit is FlavorActiV, a company based on Oxfordshire, UK who provide the sensory needs such as sensory tools and training for the global beverage industry [56]. Their sensory kit product is FlavorActiV’s GMP (Pharmaceutical Good Manufacturing Practice) Flavour Reference Standards, an encapsulated compounds which can be dissolved into any liquid to impart the aroma, taste, and mouthfeel of a specific positive or negative flavor for taster training, calibration and quality control purposes. The flavor standards are sold by flavors with 5 individually blister packaged capsules in each flavor pack. FlavorActiv supplied the flavor standard since 1996 and it have been used for numerous sensory evaluation [50,57,58].
Table 1. The latest sensory lexicon and sensory wheel.

| Product          | Number of sample | Definition | References lexicon | Character references | References intensity | Intensity | Appearance | Visual | Aroma | Texture/structural | Flavor | Taste | Affroaance | Off-notes | Feeling factor | Technical vocabulary | Wheel | References |
|------------------|------------------|------------|--------------------|----------------------|----------------------|-----------|------------|--------|-------|-------------------|--------|-------|------------|-----------|------------------|----------------------|-------|------------|
| Fruit and vegetable |                  |            |                    |                      |                      |           |            |        |       |                   |        |       |            |           |                  |                      |       |            |
| Cooked Potato    | 25               | Yes        | No                  | No                   | No                   | Yes        | -          | -      | 5     | 8                 | 11     | -     | -          | -         | No               | [15]                |       |            |
| Kale             | 15               | Yes        | No                  | Yes                  | No                   | Yes        | -          | -      | 5     | 5                 | 16     | 13    | 5          | -         | Yes              | [19]                |       |            |
| Mushroom         | 27               | Yes        | No                  | Yes                  | Yes                  | Yes        | -          | -      | -     | 27                | -      | -     | -          | -         | No               | [20]                |       |            |
| Omija Fruit      | 4                | Yes        | No                  | Yes                  | No                   | Yes        | -          | -      | 7     | -                 | -      | -     | -          | -         | No               | [14]                |       |            |
| Peach            | 51               | Yes        | No                  | Yes                  | Yes                  | Yes        | 1          | 4      | 4     | 5                 | -      | -     | 2          | No         | No               | [17]                |       |            |
| Potato           | 55               | Yes        | No                  | Yes                  | No                   | Yes        | 5          | 17     | 18    | 5                 | 3      | -     | -          | No         | No               | [15]                |       |            |
| Strawbery        | 12               | Yes        | No                  | Yes                  | No                   | No         | 2          | 10     | -     | 5                 | -      | -     | -          | No         | No               | [18]                |       |            |
| Grain and nut    |                  |            |                      |                      |                      |           |            |        |       |                   |        |       |            |           |                  |                      |       |            |
| Almond           | 4                | Yes        | Yes                 | Yes                  | No                   | Yes        | 3          | -      | 5     | 5                 | 3      | 1     | -          | -         | No               | [21]                |       |            |
| Sorghum          | 57               | Yes        | No                  | Yes                  | Yes                  | No         | Total all attributes: 27 |       |       |                   |        |       |            |           |                  |                      |       |            |
| Quinoa           | 21               | Yes        | No                  | Yes                  | No                   | Yes        | -          | -      | 9     | 12                | 7      | -     | -          | -         | No               | [22]                |       |            |
| Dried Long Pasta | 50               | Yes        | No                  | Yes                  | Yes                  | No         | 5          | 11     | 19    | -                 | -      | -     | -          | -         | No               | [24]                |       |            |
| Beverage         |                  |            |                      |                      |                      |           |            |        |       |                   |        |       |            |           |                  |                      |       |            |
| Apple Juice      | 6                | No         | Yes                 | No                   | No                   | No         | 8          | 16     | 5     | 8                 | 9      | -     | -          | Yes        | [25]             |                      |       |            |
| Barred aged beer | 4                | Yes        | No                  | Yes                  | No                   | No         | -          | -      | 60    | 3                 | 5      | -     | -          | -         | Yes              | [27]                |       |            |
| Cold Brew Coffee | 44               | Yes        | No                  | Yes                  | No                   | Yes        | -          | -      | 7     | 3                 | 3      | -     | -          | -         | No               | [29]                |       |            |
| Hunan Fuzhuan brick tea | 27    | Yes        | No                  | Yes                  | Yes                  | Yes        | 12         | -      | -     | 6                 | -      | -     | -          | Yes        | [10]             |                      |       |            |
| Mate Tea         | 18               | Yes        | No                  | Yes                  | Yes                  | Yes        | 2          | 11     | 1     | 15                | 2      | 7     | -          | -         | No               | [31]                |       |            |
| Pomegranate-Based Smoories | 4    | Yes        | Yes                 | Yes                  | Yes                  | Yes        | -          | -      | 2     | 10                | 4      | 1     | -          | No         | No               | [26]                |       |            |
| Rooibos Tea      | 69               | Yes        | Yes                 | Yes                  | No                   | No         | -          | -      | 7     | 20                | -      | -     | -          | Yes        | [32]             |                      |       |            |
| Wine             | -                | No         | No                  | No                   | No                   | No         | -          | -      | 51    | 19                | 13     | -     | -          | 1          | Yes              | [51]                |       |            |
| Milk             |                  |            |                      |                      |                      |           |            |        |       |                   |        |       |            |           |                  |                      |       |            |
| Product          | Number of sample | Definition | References lexicon | Character references | References intensity | Intensity | Appearance | Visual | Aroma | Texture/mouthfeel | Flavor | Taste | Aftertaste | Off-notes | Feeling factor | Technical vocabulary | Wheel | References |
|------------------|------------------|------------|--------------------|----------------------|----------------------|-----------|------------|--------|-------|------------------|--------|-------|------------|-----------|---------------|---------------------|-------|------------|
| Almond Milk      | 11               | Yes        | Yes                | No                   | Yes                  | -         | -          | -      | -     | 4                | 6      | 4     | 1          | No        | [33]          |
| Tigernut Milk    | 10               | Yes        | Yes                | Yes                  | Yes                  | -         | -          | -      | -     | 2                | 8      | 3     | 1          | No        | [36]          |
| Chocolate        |                  |            |                    |                      |                      |           |            |        |       |                  |        |       |            |           |               |                     |       |            |
| Chocolate        | 22               | No         | No                 | No                   | No                   | Yes       | 13         | 38     | 16    | 37               | -      | -    | -          | No        | [38]          |
| Spices           |                  |            |                    |                      |                      |           |            |        |       |                  |        |       |            |           |               |                     |       |            |
| Sichuan Pepper   | 10               | Yes        | No                 | Yes                  | Yes                  | -         | 8          | -      | 11    | -                | -      | -    | -          | No        | [39]          |
| Spices           | 45               | Yes        | No                 | No                   | No                   | No        | Total all attributes: 56 | Yes |       |                  |        |       |            |           |               |                     |       |            |
| Sauces and stock |                  |            |                    |                      |                      |           |            |        |       |                  |        |       |            |           |               |                     |       |            |
| Bean sauces      | 5                | Yes        | No                 | Yes                  | No                   | No        | 2          |        | 2     | 4                | 1      | 3    | -          | -         | No | [41]       |
| Chicken Stock    | 10               | Yes        | No                 | Yes                  | Yes                  | Yes       | 5          | -      | -     | -                | 13     | -    | -          | -         | No | [43]       |
| Doenjang         | 4                | Yes        | Yes                | Yes                  | No                   | Yes       | Total all attributes: 13 | -    |       |                  |        |       |            |           |               |                     |       |            |
| Red Sufu         | 12               | Yes        | No                 | Yes                  | Yes                  | Yes       | 1          | 4      | 4     | 4                | -      | 1    | -          | -         | No | [44]       |
| Soy Sauces       | 5                | Yes        | Yes                | Yes                  | No                   | No        | Total all attributes: 18 | No   |       |                  |        |       |            |           |               |                     |       |            |
| Snack and bakery |                  |            |                    |                      |                      |           |            |        |       |                  |        |       |            |           |               |                     |       |            |
| Narooongji - Rice-Based Snack | 4 | Yes | No | Yes | No | No | Yes | - | - | 5 | 12 | - | - | - | No | [46] |
| Rye Bread        | 32               | Yes        | No                 | Yes                  | No                   | Total all attributes: 28 | - |       |           | No | [3]        |
| Waterford Blaa Bread | 4 | Yes | No | No | No | Yes | 13 | 6 | 8 | 5 | 2 | - | - | No | [47] |
| Oil              |                  |            |                    |                      |                      |           |            |        |       |                  |        |       |            |           |               |                     |       |            |
| Marine Oil       | 20               | Yes        | No                 | Yes                  | No                   | No        | -          | -      | -     | 13               | 47     | -    | -          | Yes       | [48]          |
| Smoked food      |                  |            |                    |                      |                      |           |            |        |       |                  |        |       |            |           |               |                     |       |            |
| Smoked Food      | 24               | Yes        | No                 | Yes                  | Yes                  | No        | Total all attributes: 14 | No   |       |                  |        |       |            |           |               |                     |       |            |
4. Conclusions
The sensory lexicon, sensory wheel and sensory kits can be integrated as a comprehensive and reliable communication as well as training tools in sensory fields. In the development, it might consider background knowledge or different culture but it will surely require consistent description and precise intensity measurements of the sensory attributes. These tools are important such as to aid in the sensory panel calibration and to better understand sensory characters of certain products. Since the sensory area is continually evolving, the use of sensory lexicon, sensory wheel and kit may have lots of potential to be improved in the future. It might be beneficial not only for specific sensory panels, but also those who are interested in sensory science.

References
[1] Lawless L J R and Civille G V 2013 Developing lexicons: a review J. Sens. Stud. 28 4 270-81
[2] Moskowitz H R, Muñoz A M and Gacula M C 2004 Language development in descriptive analysis and the formation of sensory concepts in Viewpoints and controversies in sensory science and consumer product testing (Trumbull, USA: Food & Nutrition Press) p. 313–36
[3] Tran T, James M N, Chambers D, Koppel K and Chambers E. 2018 Lexicon development for the sensory description of rye bread J. Sens. Stud. 34 e12244
[4] Drake M A and Civille G V 2002 Flavor lexicons Comprehensive Reviews in Food Science and Food Safety 2
[5] Suwonsichon S 2019 The importance of sensory lexicons for research and development of food products Foods 8 27 1-16
[6] Griffin L E, Dean L L and Drake M A 2017 The development of a lexicon for cashew nuts J. Sens. Stud. 32 e12244
[7] Pickering G J and Demiglio P 2008 The white wine mouthfeel wheel: a lexicon for describing the oral sensations elicited by white wine J. Wine Res. 19 1 51–67
[8] Specialty Coffee Association 2016 How to use the coffee taster’s flavor wheel in eight steps retrieved from https://sca.coffee/sca-news/how-to-use-the-flavor-wheel-in-eight-steps
[9] Spencer M, Sage E, Velez M and Guinard J X 2016 Using single free sorting and multivariate exploratory methods to design a new coffee taster’s flavor wheel J. Food Sci. 81 12 S2997–S3005
[10] Lawless H T and Heymann H 2010 Qualitative Consumer Research Methods in Sensory Evaluation of Food Second Edition (New York: Springer) pp 379-405
[11] Fujioka K, Tomizawa Y, Shimizu N and Manome Y 2014 Description of Coffee Aroma with the Electronic Nose which Learned Wine Aromas, “Le Nez du Vin” Conference Proceedings Paper – Sensors and Applications
[12] Fujioka K, Tomizawa Y, Shimizu N, Ikeda K and Manome Y 2015 Improving the performance of an electronic nose by wine aroma training to distinguish between drip coffee and canned coffee Sensors 15 1 1354–64
[13] Dempster M 2011 A Research Guide For Health and Clinical Psychology (Hampshire: Palgrave Macmillan)
[14] Kim M K, Jang H W and Lee K G 2020 Characterization of key aroma-active compounds isolated from omija fruit treated differently based on odor activity values and descriptive sensory analysis Foods 9 5
[15] Sharma C, Chambers E, Jayanty S S, Rajakalyan V S, Holm D G and Talavera M 2020 Development of a lexicon to describe the sensory characteristics of a wide variety of potato cultivars J. Sens. Stud. 35 4
[16] Ciccone M, Chambers D, Chambers E and Talavera M 2020 Determining which cooking method provides the best sensory differentiation of potatoes Foods 9 4
[17] Belisle C, Adhikari K, Chavez D and Phan U T X 2017 Development of a lexicon for flavor and texture of fresh peach cultivars J. Sens. Stud. 32 4
[18] Oliver P, Cicerale S, Pang E and Keast R 2018 Developing a strawberry lexicon to describe
cultivars at two maturation stages. *J. Sens. Stud.* **33** 1

[19] Swegarden H, Stelick A, Dando R and Griffiths P D 2019 Bridging Sensory Evaluation and Consumer Research for Strategic Leafy Brassica (*Brassica oleracea*) Improvement *J. Food Sci.* **84** 12 3746–62

[20] Chun S S, Chambers E and Han I 2020 Development of a sensory flavor lexicon for mushrooms and subsequent characterization of fresh and dried mushrooms *Foods* **9** 8

[21] Lipan L, Cano-Lamadrid M, Corell M, Sendra E, Hernández F, Stan L, Vodnar D C, Vázquez-Araújo L and Carbonell-Barrachina Á A 2019 Sensory profile and acceptability of hydrosoStainable almonds *Foods* **8** 2

[22] Wu G, Ross C F, Morris C F and Murphy K M 2017 Lexicon development, consumer acceptance, and drivers of liking of quinoa varieties *J. Food Sci.* **82** 4 993–1005

[23] Tran T 2014 Sorghum utilization as food *J. Nutr. Food Sci.* **04** 01 1000247

[24] Irie K, Maeda T, Kazami Y, Yoshida M and Hayakawa F 2018 Establishment of a sensory lexicon for dried long pasta *J. Sens. Stud.* **33** 4

[25] Da Silva T M, Marinoni D T, Peano C and Giuggioli N R. 2019 A new sensory approach combined with a text-mining tool to create a sensory lexicon and profile of monovarietal apple juices *Foods* **8** 12

[26] Issa-Issa H, Cano-Lamadrid M, Calin-Sánchez Á, Wojdylo A and Carbonell-Barrachina Á A 2020 Volatile composition and sensory attributes of smoothies based on pomegranate juice and mediterranean fruit purées (Fig, Jujube and Quince) *Foods* **9** 7

[27] Silvello G C, Bortoleto A M and Alcarde A R 2020 The barrel aged beer wheel: a tool for sensory assessment *J. Inst. Brew.* **126** 4 382–93

[28] Perrin L and Pagès J 2009 Construction of a product space from the ultra-flash profiling method: Application to 10 red wines from the loire valley *J. Sens. Stud.* **24** 3 372–95

[29] McCain-Keefer H R, Meals S and Drake M A 2020 The sensory properties and consumer acceptance of cold brew coffee *J. Sens. Stud.* **35** 6

[30] Li H H, Luo L Y, Wang J, Fu D H and Zeng L 2019 Lexicon development and quantitative descriptive analysis of Hunan fuzhuan brick tea infusion *Food Res. Int.* **120** 275–84

[31] de Godoy R C B, Chambers E and Yang G 2020 Development of a preliminary sensory lexicon for mate tea *J. Sens. Stud.* **35** 3

[32] Koch I S, Muller M, Joubert E, van der Rijst M and Næs T 2012 Sensory characterization of rooibos tea and the development of a rooibos sensory wheel and lexicon *Food Res. Int.* **46** 1 217–28

[33] Lipan L, Rusu B, Simon E L, Sendra E, Hernández F, Vodnar D C, Corell M, Carbonell-Barrachina Á A 2021 Chemical and sensorial characterization of spray dried hydrosoStainable almond milk *J. Sci. Food Agric.* **101** 4 1372–81

[34] Adhikari K, Dooley L M, Chambers IV E and Bhumiratana N 2010 Sensory characteristics of commercial lactose-free milks manufactured in the United States *LWT - Food Sci. Technol.* **43** 1 113–18

[35] Vázquez-Araújo L, Chambers D and Carbonell-Barrachina Á A 2012 Development of a sensory lexicon and application by an industry trade panel for turrón, a European protected product,” *J. Sens. Stud.* **27** 1 26–36

[36] Clemente-Villalba J, Cano-Lamadrid M, Issa-Issa H, Hernandez F, Carbonell-Barrachina Á A and Lluch D B L 2020 Comparison on sensory profile, volatile composition and consumer’s acceptance for PDO or non-PDO tigernut (*Cyperus esculentus*) milk *LWT-Food Sci. Technol.* **140** 2

[37] Clemente-Villalba J, Ariza D, Garcia-Garvi J M, Sánchez-Bravo P, Noguera-Artiaga L, Issa-Issa H, Hernandez F and Carbonell-Barrachina Á A 2020 Characterization and potential use of Diplotaxis erucoides as food ingredient for a sustainable modern cuisine and comparison with commercial mustards and wasabises *Eur. Food Res. Technol.* **246** 7 1429–38

[38] De Pelsmaeker S, De Clercq G, Gellynck X and Schouteten J J 2019 Development of a sensory
wheel and lexicon for chocolate Food Res. Int. 116 1183–91
[39] Yang G, Chambers E and Wang H 2021 Flavor lexicon development (in English and Chinese) and descriptive analysis of Sichuan pepper J. Sens. Stud. 36 2
[40] Lawless L J R, Hottenstein A and Ellingsworth J 2012 The McCormick spice wheel: A systematic and visual approach to sensory lexicon development J. Sens. Stud. 27 1 37–47
[41] Byarugaba R, Nabubuya A and Muyonga J 2020 Descriptive sensory analysis and consumer preferences of bean sauces Food Sci. Nutr. 8 8 4252–65
[42] Jo Y and Kim M K 2020 Influences of appearance characteristics on consumer acceptance and perception of ‘gu-soo’ in fermented soybean paste (doenjang) J. Sens. Stud. 35 5
[43] Kim H, Lee J and Kim B 2017 Development of an initial lexicon for and impact of forms (cube, liquid, powder) on chicken stock and comparison to consumer acceptance J. Sens. Stud. 32 2
[44] He W, Chen Y P and Chung H Y 2018 Development of a lexicon for red sufu J. Sens. Stud. 33 6
[45] Reddy T R, Overmyer K A, Coon J J, Drake M, Horiba T and Rankin S A 2021 Metabolomic Biomarkers Differentiate Soy Sauce Freshness under Conditions of Accelerated Storage J. Food Qual. 1–11
[46] Kim M K 2020 Sensory profile of rice-based snack (nuroongji) prepared from rice with different levels of milling degree Foods 9 6 1–12
[47] Kelly R, Hollowood T and Scannell A G M 2019 Sensory characterisation of an Irish PGI bread: Waterford Blaa Eur. Food Res. Technol. 245 6 1307–19
[48] Larssen W E, Monteleone E and Hersleth M 2018 Sensory description of marine oils through development of a sensory wheel and vocabulary Food Res. Int. 106 45–53
[49] Jaffe T R, Wang H and Chambers E 2017 Determination of a lexicon for the sensory flavor attributes of smoked food products J. Sens. Stud. 32 3
[50] du Preez B V P, de Beer D, Moelich E I, Muller M and Joubert E 2019 Development of chemical-based reference standards for rooibos and honeybush aroma lexicons Food Res. Int. 127
[51] Croijmans I, Hendrickx I, Lefever E, Majid A and van Den Bosch A 2019 Uncovering the language of wine experts Nat. Lang. Eng. 26 5 511–30
[52] Editions Jean Lenoir Le Nez du Café Revelation 36 aromas Retrieved from www.lenz.com/en/kits/coffee/revelation
[53] Tao Y S, Liu Y q and Li H 2009 Sensory characters of cabernet sauvignon dry red wine from changli county (china) Food Chem. 114 2 565–69
[54] Scentone Scentone Coffee Flavor Map T100 + VIC100 Retrieved from https://scentone.org/worldshop?idx=1 (accessed Jun. 29, 2021)
[55] Sensoflavo Sensory Collaborative Works 2020 Sensoflavo Coffee Aroma Library Retrieved from https://sensoflavo.com/ (accessed Jun. 29, 2021)
[56] FlavorActIV 2021 GMP Pharma Flavour Standards Retrieved from https://gbp.flavoractiv.com/ (accessed Jun. 29, 2021)
[57] Jaskula-Goiris B, De Causmaecker B, De Rouck G, Aerts G, Paternoster A, Braet J and De Cooman L 2019 Influence of transport and storage conditions on beer quality and flavour stability J. Inst. Brew. 125 1 60–68
[58] Piornos J A, Balagianis D P, Melhven L., Koussi E, Brouwer E and Parker J K 2020 Elucidating the Odor-Active Aroma Compounds in Alcohol-Free Beer and Their Contribution to the Worthy Flavor,” J. Agric. Food Chem. 68 37. 10088–96